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TASK FORCE ON INTEGRATED ENERGY AND ENVIRONMENTAL PLANNING

Volume IV: Verification and extension of the Polish energy and environmental data base

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Organizational framework of the study

This study is part of the project 'Task Force on Integrated Energy and Environmental Planning' which was made possible through financial support from the Dutch Government in the framework of the PSO programme. The projectleader was Mr. N.H. van der Linden (Netherlands Energy Research Foundation, Unit ECN Policy Studies). The study team consisted of Mr. W.G. van Arkel (Netherlands Energy Research Foundation, Unit ECN Policy Studies), Mrs. Z. Grajwoda (Polish Oil & Gas Company, Economics and Marketing Department), Mr. Z. Klimont (Polish Institute of Fundamental Technological Research, Department of Energy Problems) and Mr. J. Nowakowski (Polish Ministry of Industry and Trade, Department of Energy).

Abstract

The current study concerns a comparison between Polish and Dutch data on energy technologies associated with the energy models SELPE, ENPEP and DORSEK-E. In addition, the data base of the Polish Ministry of Industry and Trade was used as a reference for the current situation in Poland. The aim of this comparison was to verify the contents of the Polish data bases, and to extend the Polish data bases with energy technologies which will become available in the near future and with abatement technologies to reduce the SO_2 and NO_x emissions. It turned out that many differences exist between the data bases. In a number of cases these differences can be explained by a different use of the data by the energy models, but in other cases data were adjusted according to the most recent information. The data base comparison also considered how the energy sector is mathematically described by the models, and a number of recommendations are made. In addition to energy and environmental data, special attention was paid to the technologies within the refinery sector.

Keywords

ENERGY MODEL
CONVERSION PROCESS
ABATEMENT TECHNOLOGY
REFINERY PROCESS
DATA BASE

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PREFACE

The political and economic reforms in Central and Eastern Europe brought about a change towards more market oriented energy policies. This change can be characterized by:

- A shift in emphasis from a supply oriented energy planning to a more integrated supply and demand oriented policy.
- A shift from a plan fulfilment objective towards a more profitability oriented objective.
- A growing concern about environmental protection.
- A change of priorities, roles and responsibilities of the various governmental institutions and entrepreneurs involved in the energy sector.

The new political situation in Central and Eastern Europe has also created the possibility to intensify and extend the co-operation in different fields between the former socialist countries and Western countries. Projects carried out jointly by Research Institutes in Western and Eastern Europe can provide the opportunity to exchange knowledge and experience, and stimulate the political and economic integration.

Facing such radical changes, the Polish government wished to establish a co-operation between Research Institutes in Poland and the Netherlands in order to be able to analyze the consequences of these changes for their energy policy, and to accelerate the process of integration of the Polish energy sector into the Western Europe structure. In August 1991, a co-operation was established between Research Institutes in Poland and the Netherlands Energy Research Foundation. This co-operation was formalized by establishing a 'Task Force on Integrated Energy and Environmental Planning'. The Task Force conducts studies on issues which are important for the formulation of energy policy in Poland. These studies are identified in close co-operation with the Ministry of Industry and Trade, Department of Energy, the Ministry responsible for energy policy in Poland.

The Task Force consists of the following Institutes:

- The Ministry of Industry and Trade, Department of Energy, Warsaw (MOIT).
- The Institute of Fundamental Technological Research, Department of Energy Problems, Warsaw (IPPT/PAN).
- The Polish Gas and Oil Company.
- The Polish Foundation for Energy Efficiency, Warsaw.
- The Netherlands Energy Research Foundation, Unit ECN Policy Studies, Petten (ECN).

The primary tasks of the Task Force are:

1. To perform studies on issues which are important for the current energy policy in Poland.
2. To organize workshops in order to present and discuss the results of the studies to experts including experts not directly involved in the project.
3. To establish a co-operation between Polish Energy Research Institutes and the Netherlands Energy Research Foundation.

The first four studies identified as being very important for the formulation of energy policy in Poland are:

I. Organizational and Institutional Aspects of Energy Planning Studies.
II. Energy Demand, including:
   - development of a General Equilibrium Model for Poland
   - energy conservation
III. Comparison and evaluation of the results of three sets of energy models.
IV. Verification and extension of the Polish energy and environmental data base.

The project comprising these four studies started in April, 1992. The project was funded by the Dutch PSO Programme (Programme Co-operation with Central and Eastern Europe). The PSO Programme was established in 1990 by the Dutch Government to support the reforms in Central and Eastern Europe and provides funding for projects in different research areas including projects focusing on energy related issues.

The methodology and results of the studies performed by the Task Force are described in a series of publications entitled 'Task Force on Integrated Energy and Environmental Planning'. The series contains the following volumes:

- Volume I, Institutional Organisation of the Energy Administration in the EC countries and Poland; Three working papers are related to this Volume:
  - Working Paper I:
    Description of Former and Current Energy Administration of Poland.
  - Working Paper II:
    Government Institutions of the Energy Sector in the EC countries.
  - Working Paper III: Description of the Energy Administration in the Netherlands and in Germany.
- Volume II, Integrated Energy-Economy-Environment Policy in Poland; A Computable General Equilibrium Modelling Approach.
- Volume III, A comparison of the energy models DORSEK, ENPEP and EFOM.
- Volume IV, Verification and Extension of the Polish Energy and Environmental Data Base.

1. INTRODUCTION

This study reviews the contents of the data bases associated with the energy models DORSEK-E, ENPEP and SELPE, and the energy data base being used by the Polish Ministry of Industry and Trade (MOIT). The study presents an overview of the information on energy and environmental technologies stored in the data bases and evaluates the differences between the data bases.

The Research Institutes participating in the Task Force all have energy models at their disposal in order to quantify the consequences of policy measures. The Institute of Fundamental Technological Research, Department of Energy Problems, Warsaw, has developed the DORSEK-E model, the Polish Oil & Gas Company, Warsaw, uses the ENPEP model for their energy studies and the Netherlands Energy Research Foundation, unit ECN Policy Studies employs the SELPE model for the development of long term energy scenarios for the Netherlands.

These three energy models have an associated data base containing detailed information on energy conversion technologies and technologies for the abatement of SO_2 and NO_x emissions. This information includes data on the fixed and variable costs of the technologies, technical lifetime, efficiency and emission factors. The reliability of this information is of utmost importance and to a large extent determines the reliability of the results of the energy models.

The main objectives of this study are: 1) to verify the data on energy technologies in the Polish data bases and, if necessary, to update this data according to the most recent information; 2) to extend the Polish data bases with advanced technologies which may be used in the near future, and with technologies for the abatement of emissions.

To achieve these objectives a comparison of the contents of the Polish and Dutch data bases was performed. This comparison comprises all the characteristics of the technologies included in the data bases and consists of the following steps:

- Standardization of formats of data on energy technologies stored in Polish and Dutch data bases.
- Comparison of information on energy technology processes.
- Evaluation of possible discrepancies and update/extension of the Polish data base.

The data used by the Polish energy models are mainly taken from the data base developed and maintained at MOIT. In turn, MOIT collects the data from a number of statistical institutes situated all over Poland. Because of the important role the MOIT data base plays, it was decided also to include this data base in the comparison.

This study was conducted jointly by the Institute of Fundamental Technological Research, Department of Energy Problems, Warsaw, the Gas and Oil Company, Warsaw, the Polish Foundation for Energy Efficiency, the

Netherlands Energy Research Foundation, Unit ECN Policy studies, and the Ministry of Industry and Trade, Department of Energy, Warsaw.

Because the study was physically performed at four different Institutes, a frequent exchange of visits was necessary to ensure that the whole study was properly co-ordinated. The Dutch team visited Poland three times, and the Polish experts spent one week at ECN at the end of the project.

This report is laid out as follows. Chapter 2 gives a general brief description of the Polish and Dutch energy models and of the data base of the Polish Ministry of Industry and Trade. Chapter 3 provides detailed information on the data bases and Chapter 4 presents the differences between the data bases. Finally, Chapter 5 summarizes the results of the study.

Three Appendices are attached to this report. Appendix A contains detailed information on the energy conversion processes included in the data bases. Appendix B contains data on technologies for the abatement of SO_2 and NO_x emissions and particulate emissions. Appendix C gives very detailed information on each process within the refinery sector.

2. DESCRIPTION OF THE ENERGY MODELS

2.1 The DORSEK-E model

DORSEK-E is one of three mathematical models which form the energy - environment set of models SPSEK-E (figure 2.1). This set facilitates the investigation of the development of the energy system in relation to economic growth. The final energy demand, calculated by another model of the set (PROSK-E), provides input information for the dynamic linear programming model DORSEK-E. DORSEK-E ensures an optimum choice of technologies in energy production and conversion as well as the optimum level of exports and imports of fuels and energy. The model computes demand for primary energy, as well as costs of national energy supplies. This model is also used to choose environmental protection technologies in order to meet emission targets at a national level. The model can be used to analyze the effectiveness of environmental legislation, environmental impact of fuel switching etc.

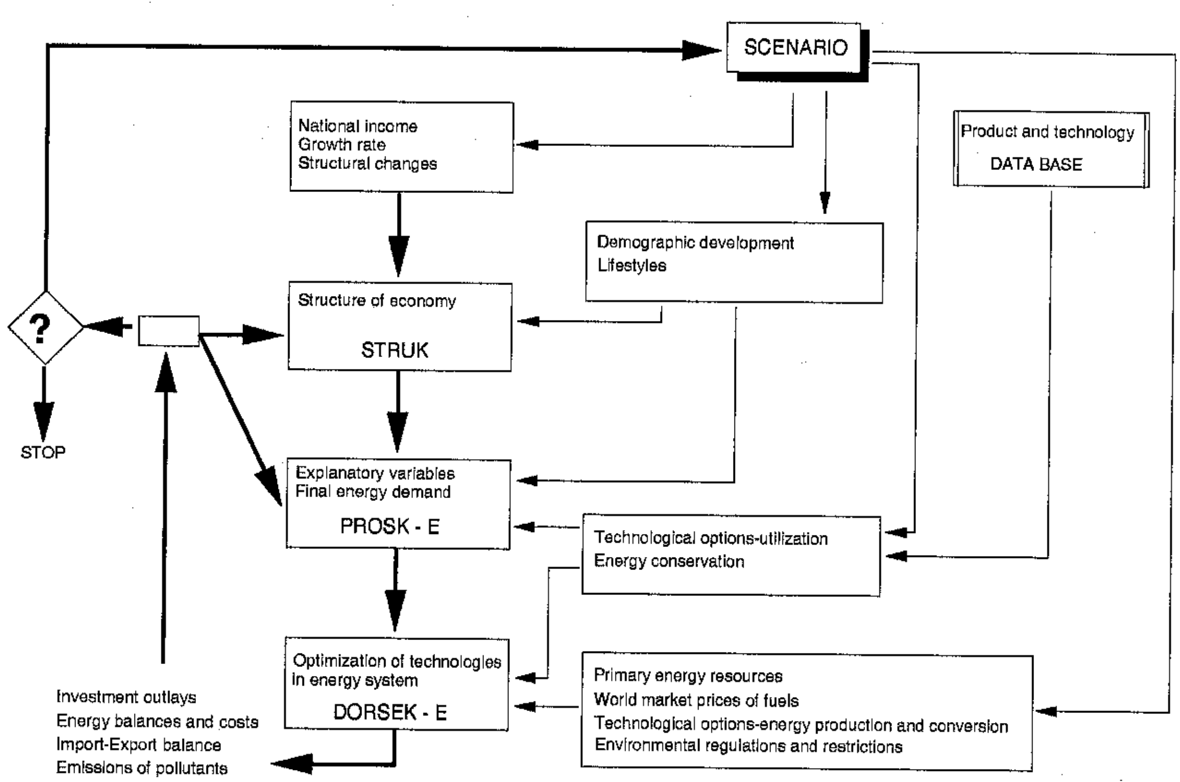

Figure 2.1 *Structure of the SPSEK-E set of models*

DORSEK-E is a dynamic linear model formulated as a linear programming problem. It is adapted to operate over a 20-25 year time horizon which is divided into 5-year periods. Linearity of the model is ensured because both the objective function as well as constraints (equations and inequalities) are linear with respect to decision variables. The decision variables in the model include production and production capacities of the energy carriers considered in the model as well as exports and imports of fuels and energy.

The input tables are ASCII files and contain lists and characteristics of technologies (new and existing production and abatement technologies) used in the model as well as characteristics of the fuels and information provided by the PROSK-E model about final energy demand.

The solution of the DORSEK-E model makes it possible to establish the primary energy balance sheet, to calculate the emissions of pollutants from energy production and conversion and to assess the investments and foreign exchange, which are necessary for the running of the system.

The DORSEK-E model has been used several times (as a part of the SPSEK-E set of models) in analyses of Polish energy system development. In 1990-1992 it was applied in the preparation of proposals for Polish energy policy up to the year 2010. Recently it has been used in the study 'Poland: Economic Policy Instruments for the Control of Air Pollution' prepared for the World Bank where the impact of different regulations and economic instruments on the environment was simulated.

2.2 The ENPEP model

General

The ENPEP (Energy and Power Evaluation Program) model is a product of the Argonne National Laboratory. It is an integrated planning package used for performing the complex study evaluating a country's energy needs and corresponding resource requirements and environmental impacts. A user is guided to seven modules through a hierarchy of menus and forms. Automated spreadsheets are used for data input and tabular computations. Upper level programming languages have been used for simulation and optimization.

Modules

ENPEP is an integrated modular system consisting of the following 8 modules:

MACRO	This module allows the user to specify global data and format macroeconomic projections.
DEMAND	Energy demands are projected for the BALANCE module based on growth information from MACRO.
PLANTDATA	Technical data on electric generating plants are formatted for the BALANCE and ELECTRIC modules.
BALANCE	In this module the balance between supply and demand is made using data from MACRO, DEMAND and PLANTDATA.
LOAD	In this module the user is allowed to coordinate electricity sector information from the previous modules and to supply additional information about electricity load calculations.
MAED	Here it is possible for the user to simulate different socioeconomic and technical development scenarios for the country to determine the resulting energy demand and if desired, to provide electricity demand forecasts which can be used for the ELECTRIC module.

ELECTRIC The module which selects a minimum cost generation supply system to meet electricity load demand and reliability goals within other user imposed constraints.

IMPACTS This module serves as a decision aid by integrating information about energy supply system resource requirements and environmental impacts.

How it works

Each module deals with a specific aspect of the energy and power evaluation process. This modular organization produces several benefits: the user may run each module independently. The information flow between modules is shown in figure 2.2.

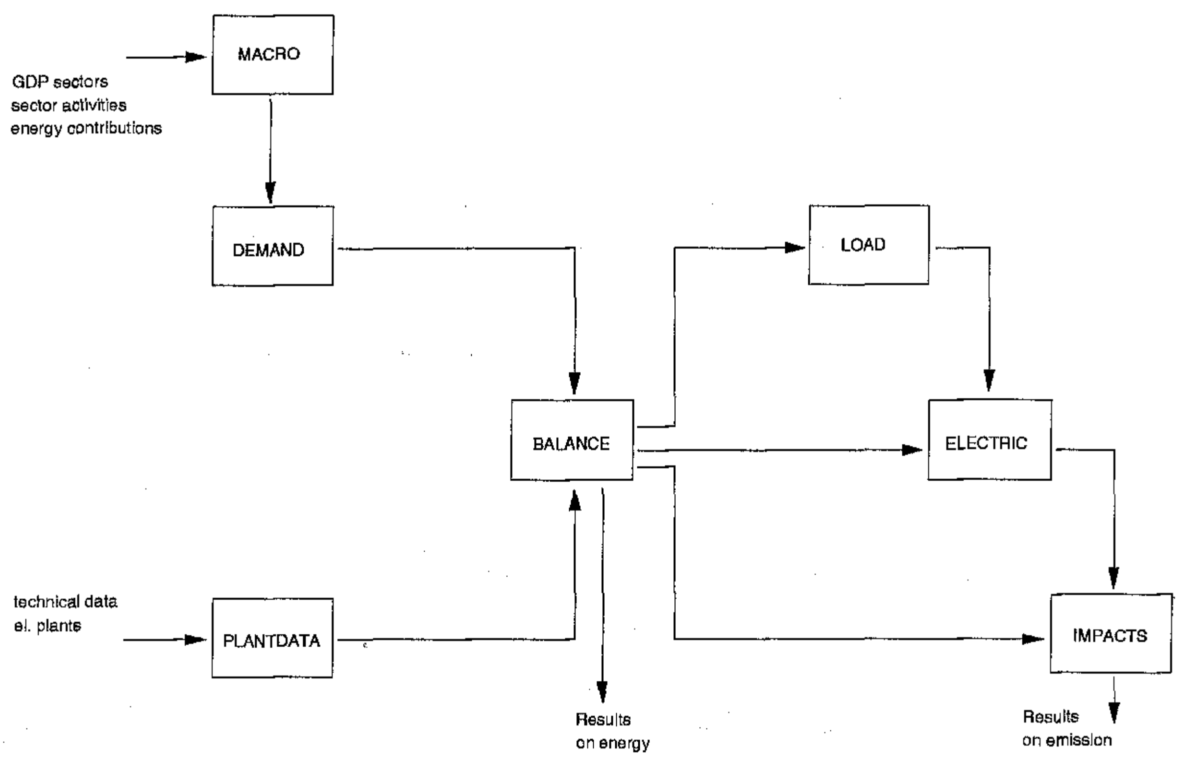

Figure 2.2 *Structure of the ENPEP model*

The BALANCE model is the main module of the system describing the energy and fuel sector by different nodes connected by a set of links. Each node (depletable and renewable resources, conversion, decision, pricing, refinery, electric) has its own characteristic data. The user can make an own defined time flow energy network with the prospect from base year to last planning year (up to 30 years). Recently a data set for MACRO, DEMAND, BALANCE, ELECTRIC modules and a part of information for the IMPACTS module has been prepared.

The MACRO module is supported by another own simulation module (DMS) made in MEC/PAN, which calculates macroeconomic growth branches of the national economy (see demand aggregation) and is based on:

- Participation of sectors in producing the total GDP.

- Changes of activities about global production per sector as a structure of investments effects in the sector of material production.
- Changes of energy contributions (solid fuels, liquid fuels, gas fuels, and electricity) in the consumption structure.

DEMAND uses information from MACRO as follows:
- Global production per sector (see aggregation of energy and fuel consumers).
- The demographic changes (source GUS).
- Elasticities of fuel demands with respect to the economic activities (GDP, GDP by sectors, demographic),source statistical time series 1970-1989.
- External analyses about export of fuels and household fuel demands.

DEMAND generates reports about fuels demand changes by consumers to BALANCE.

PLANTDATA is a tool prepared to operate on the data set relevant to power plants. The above data are prepared directly for BALANCE without using of PLANTDATA module.

For the IMPACTS module there is a generic facility database that includes the following:
- Physical/technical characteristics
- Economic characteristics
- Emission factors for the fuel used
- Air pollution control
- Water pollution
- Water pollution control
- Solid waste generation
- Solid waste control.

2.3 The SELPE model

At ECN Policy Studies the model SELPE (figure 2.3) is used to explore the future energy supply options of the Netherlands. It is a static Linear Programming model written in GAMS (General Algebraic Modelling System). MINOS5 is used as the solver. SELPE minimizes the total costs of the energy system and upper bounds can be imposed on the total emission of SO_2, NO_x and CO_2. SELPE is the core model of the study entitled 'The National Energy Outlook' , carried out every five years on behalf of the Dutch Government to explore the Dutch energy future.

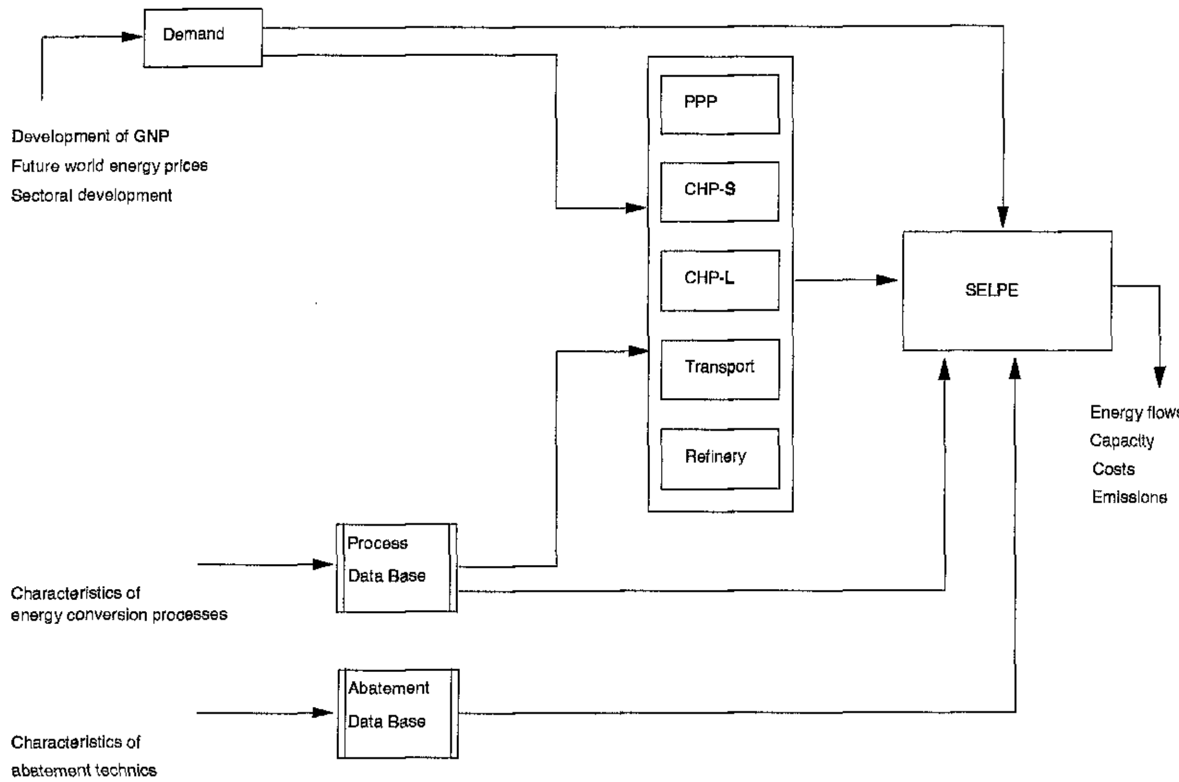

Figure 2.3 *Structure of the SELPE model*

Each energy supply scenario is based on assumptions about future energy demand. Two databases are associated with the SELPE model; a data base containing information on energy conversion technologies and a separate data base used for storing data on abatement technologies. In addition to the SELPE model, more specialized sector models offer the possibility to analyze in detail the development in different sectors viz. public power, cogeneration, refineries and transport.

The model distinguishes 5 energy supply *sectors*: coal, oil, natural gas, electricity and heat. The *demand sectors* are households, government, industry, business and transport. Each sector consists of two or more subsectors. In the model these subsectors are called *producers*. Every *producer* contains processes in which energy carriers are converted. In most cases analogue processes are combined in so called *plants*. In the demand sectors there is a production of useful energy.

The main parts of the SELPE model are:
- General declaration of all elements used in the model.
- The mapping of processes in producers and plants.
- A table with the characteristics of all processes.
- A table with source flows to producers (incl. bounds).
- A table with intermediate flows between producers (incl. bounds).
- A table with flows from producers to demand categories (incl. bounds).
- The equations of the model.

The table with the characteristics of the processes is generated by a separate program written in Pascal and using a dBase input file. The data in this dBASE file is used in different modules.

2.4 The MOIT data base

The Polish Ministry of Industry and Trade is the main recipient of current energy statistical information. This information is prepared by the following institutions involved in energy statistics:

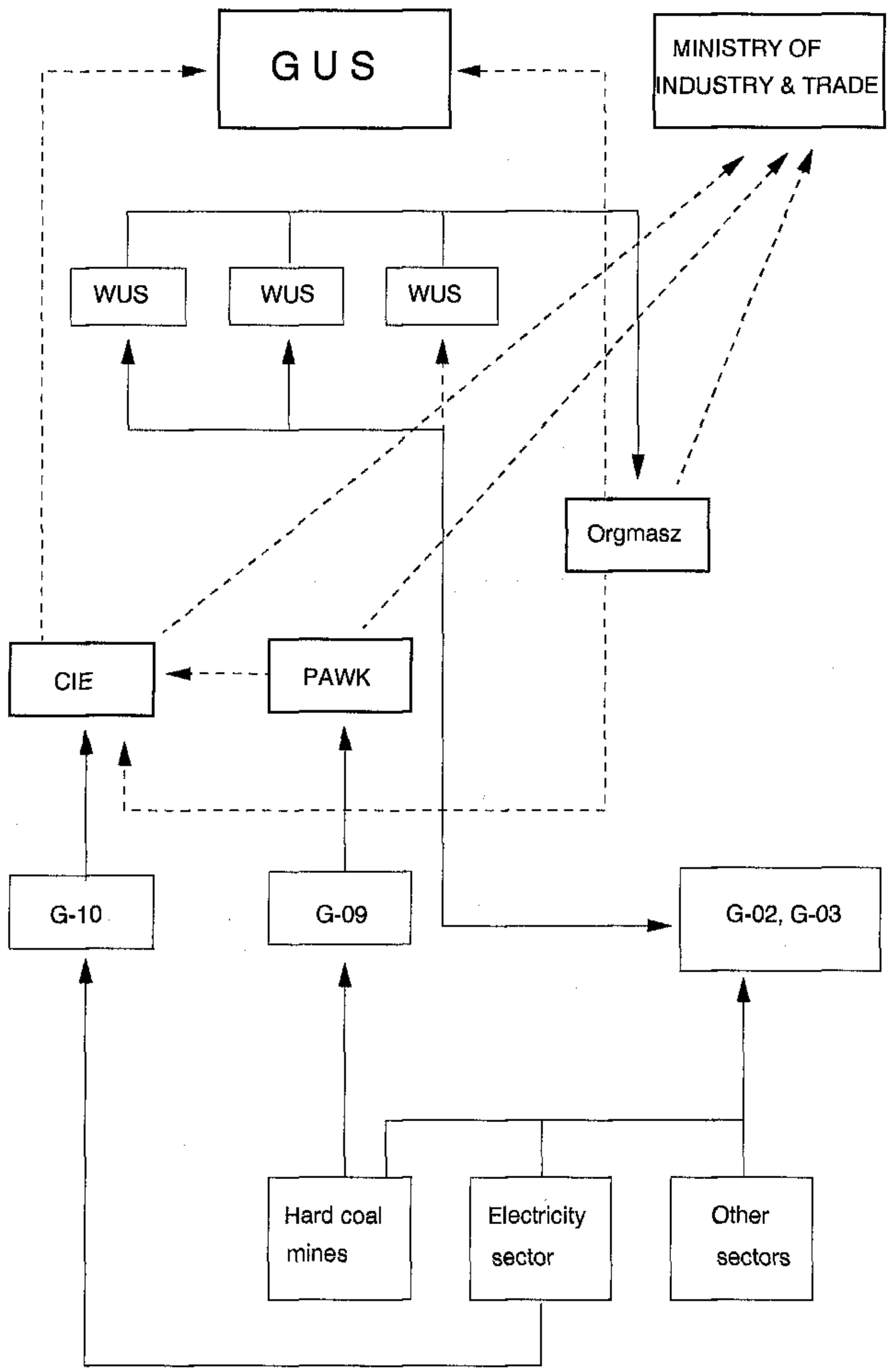

Figure 2.4 *Organisation chart of statistical institutes*

Energy Information Centre (CIE):
- Supervises the whole energy statistics process from data collection and data processing.
- Collects and directly processes the data from the electricity sector.
- Stores all the current and historical data bases.
- Prepares the main domestic publications.
- Supplies the required data on request from various institutions.

Regional Statistical Offices (WUS - there are 49, one in each administrative province):
- Collect the statistical reports from the companies in their province.
- Perform data coding and preliminary verification.
- Send the magnetic media to Orgmasz where the central data processing takes place.

Orgmasz (Institute of Machinery Industry):
- Performs the central processing of reports, including full verification.
- Passes the verified and properly aggregated data to the Ministry of Industry and Trade and to the Energy Information Centre.

State Hard Coal Agency (PAWK):
- Collects, verifies and processes the data from hard coal mines.
- Passes the verified and aggregated data to the Ministry of Industry and Trade and to the Energy Information Centre.

Legislative framework

In Poland the provision of energy statistics is obligatory. The Central Statistical Office (GUS) is responsible for the supervision of the data collection process. The general rules of statistical data collection and dissemination are defined by the 1982 Parliament Act on Statistics, with 1989 amendments.

Pursuant to this Act and the CSO President instructions all the individual data are confidential. The confidentiality is strictly observed in the case of financial and economic data. Disclosure of some individual technical information (for example on electricity generation and installed capacities) is allowed.

3. DESCRIPTION OF THE DATA BASES

3.1 Approach

In chapter 2 it was shown that the type of information (characteristics of the energy process such as costs, efficiency and fuel use) stored in the three data bases is very similar. This means that a comparison between the data is possible. This comparison comprises the following activities:
- Standardization of formats of data on energy technologies stored in Polish and Dutch data bases.
- Comparison of information on energy technology processes.
- Evaluation of possible discrepancies and update/extension of the Polish data base.

3.2 Description of the data bases

DORSEK-E

The data base associated with the DORSEK-E model contains approximately 60 existing and 70 new energy technologies. In addition, data on more than 100 abatement technologies is stored in the data base.

Conversion and production

The technologies have been aggregated into representative groups such as industrial power and heat plants, municipal heating plants, coke oven plants, coal mines, gas and oil fields and refineries. The existing objects are represented in DORSEK-E by variables describing the production of the reference energy carrier in each technology considered. The maximum available energy production from existing objects of a given group (for example from hard coal fired power plants) is defined exogenously to the model on the basis of detailed branch investigations performed by other institutions such as the Power Research Institute for electric utilities. These institutions also deliver data on the investments required to maintain production and to rehabilitate the existing objects.

Consumption and production of energy in new objects is given in GJ/tce (tce - ton of coal equivalent = 29.3 GJ) output excluding refineries where it is GJ/tce input. For existing objects this data is expressed in GJ/GJ. The capacity is defined as annual production (output) in tce/a, except for refineries where it is given as an annual input (tce/a). The efficiency is the ratio between the total output and total input. The specific investment costs are given in million Zl (January 1991 prices) per unit of annual output in tce and they do not include interest during construction. The operation and distribution costs are given in million Zl per tce output. Environmental characteristics of the technologies include such parameters as water consumption, land use, sewage, emission of SO_2, NO_x, CO_2, methane and particulates, solid waste deposit, limestone use, CaO and limestone powder use, gypsum production and ammonia use as well as labour. These data are given in cubic metres, square metres, tonnes or employee per tce output respectively. The lifetime of technologies in the energy sector was assumed to be 30 years, the discount rate was set at 12% and the US dollar exchange rate at 10,000 Zl/USD.

The model also takes into account new technologies of the integrated type. The specific conditions under which these technologies can be applied in Poland is currently being discussed. Introduction of these technologies may lead to an abrupt reduction in emissions. These technologies include:
- steam-gas combined cycle power plants,
- power and heating plants with fluidized bed boilers,
- production of synthesis gas and medium BTU gas,
- methanol from hard coal and lignite,
- oil residuals gasification.

The DORSEK-E model treats the problem of time dependence of demand for fuel and energy in a simple manner. Each technology has a typical capacity factor and its value is fixed based on past experience. For example, for technologies of electricity and heat production the following capacity factors have been assumed:
- New public power plants (PPP)
  0.74 (t= 6500 h/a)
- Existing lignite fired PPP
  0.68 (t= 6000 h/a)
- Existing hard coal fired PPP
  0.60 (t= 5500 h/a)
- New public combined heat and power plants (CHP)
  - electrical capacity
    0.55 (t= 4800 h/a)
  - thermal capacity
    0.30 (t= 2600 h/a)
- Existing public combined heat and power plants (CHP)
  - electrical capacity
    0.46 (t= 4000 h/a)
  - thermal capacity
    0.25 (t= 2200 h/a)
- Industrial combined heat and power plants (IPP)
  - new
    0.37 (t= 3200 h/a)
  - existing
    0.32 (t= 2800 h/a)
- Industrial heating plants (IHP)
  - new
    0.30 (t= 2600 h/a)
  - existing
    0.30 (t= 2600 h/a)
- Municipal heating plants
  0.25 (t= 2200 h/a)

The same capacity factors are assumed for environmental protection technologies, which are combined with energy production technologies.

The DORSEK-E model allows for modelling inter fuel substitution in existing technologies, for example, replacement of low quality high sulphur coal by coal of better quality, switch from coal to gas etc. The investment costs associated with such substitutions are relatively small and they are therefore not specified in the model. It has been assumed that they are included in the general quota of investments needed to maintain production from existing objects. Only efficiency and operation costs depend on the type and quality of fuel consumed. The range of substitution is limited by upper bounds imposed on the production levels of existing technologies. Energy production from existing technologies is also constrained by special constraints which ensure that the production is not higher than existing capacities.

Abatement technologies

Because the cost differences in applying abatement technologies depends on whether these are used in existing or new plants, characteristics of the technologies differ. The following abatement technology groups are implemented in the model:

- Hard coal cleaning with desulphurization.
- Flue gas desulphurization in hard coal fired power and heating plants:
  - spray dryer method
  - wet limestone method
- Flue gas desulphurization in lignite fired power plants:
  - dry method
  - wet method
- Flue gas denitrification in power plants (primary measures i.e. combustion modifications, SCR method).
- A whole range of electrostatic precipitators or bag filters for existing power and heating plants.

Each emission abatement technology is represented in the model by two decision variables, namely:

- Activity level (production) in a given sub period.
  Activity levels of abatement technologies are defined by a quantity of energy carrier produced annually by plants equipped with the technology considered.
- Increase in production capacity of the technology in a given sub period.

The production variables for emission abatement technologies have negative emission factors which are equal to the quantity of pollutant reduced per unit of energy carrier produced.

Balances of production capacities for abatement technologies are identical with analogous balances for energy production technologies. It is possible to put bounds on abatement technologies in the same way as the other decision variables in the model.

Each abatement technology must be properly 'connected' to an energy production or conversion technology. This is achieved through an additional group of constraints, which ensure that the activity level of abatement technology cannot be higher than energy carrier production.

Optimization

The DORSEK-E model is equipped with matrix generator/report writers written in Turbo Pascal 4.0 and 6.0. The model is solved on a SUN workstation as well as on an AT microcomputer equipped with a Motorola 68020 coprocessor having 2 MB RAM memory. The XMP package is used as a solver. This package has been extended in order to make it possible to start the computations using previous basic solutions. In the present version the model includes more than 2200 variables and about 1800 constraints. Average computation time on PC computer is 10 to 30 minutes.

ENPEP

The data base associated with the ENPEP model contains many data. Table 3.1 shows the different types of data, and the characteristics for each type.

Table 3.1 *Data structure in ENPEP model*

Node	Type of data	Characteristics	Dimension
Depletable resource	Import, depletable fuels	Price supply Parameters price/quantity function, Base year quantity Annual capacity limit Price projection	$/BOE 1000 BOE 1000 BOE/y
Renewable resource	Wood & peat Nuclear fuel	Price supply as a function of quantity Quantity Base year quantity Annual capacity	1000 BOE 1000 BOE 1000 BOE 1000 BOE/y
Conversion process	One input, one output	Operating & Maintenance Output/input ratio Total capital investment Capacity factor (use) Life expectancy Capacity of all plants Capacity of single plant	$/BOE (out) 1000 $ year 1000 BOE 1000 BOE
	Multiple output, as gas mixing plants	See 'one input, one output'	
	Multiple input, as refineries and coke plants	See 'one input, one output'	
Electricity sector	Unit	Base year production Peak fraction Reserve margin Capacity Capital cost Fixed O&M cost Variable O&M cost Heat rate Forced outage rate Planned outage rate Initial exploitation Unit total life Min. annual utilization	1000 BOE MW_e $/kW $/kW 0.001 $/kWh Btu/kWh days/year year year

For the IMPACTS module a so called generic facility database is used. In this database a list of facility types is given. A facility type defines an engine used for energy conversion, the related capacity, the sector where it is used and an overview of available data about costs and emissions. So for every process a type of facility must be chosen.

As an example for the unit COAL500 in the electricity sector, it is supposed that this unit has a coal fired dry bottom wall boiler. In addition, there is a database of emission control devices with data about the effects and the costs of using the device. To execute the IMPACTS module it is necessary to declare 'specific facilities', this means a combination of a generic facility with emission control devices.

The generic facility database includes the following facility characteristics:

Physical/technical characteristics
- Number of input and output
- Output capacity [GJ/year]
- Output/Input ratio as a fraction
- Input capacity [GJ/year]
- Capacity factor as a fraction.

Economic characteristics
- Capital costs [$/GJ input capacity]
- Annual O&M costs [$/GJ input]
- Interest rate as a fraction
- Life expectancy [years]
- Construction time [years].

Emission factors by fuel
- Particulates
- Sulphur oxides expressed as SO_2
- Nitrogen oxides expressed as NO_2
- Carbon dioxide
- Others (methane, VOC, carbon monoxide).

Air pollution control
- For device combinations the separate constituent devices
- Capital cost [$/GJ input capacity]
- Annual O&M costs [$/GJ input]
- Removal efficiency [%] for different pollutants.

Cost and performance data for air emission control devices
- Device or combination of devices
- Capital costs [$/kW] and [$90/GJ capacity input]
- O&M costs [$/year] and [$90/GJ input]
- Removal [%].

In the Polish situation American data is used.

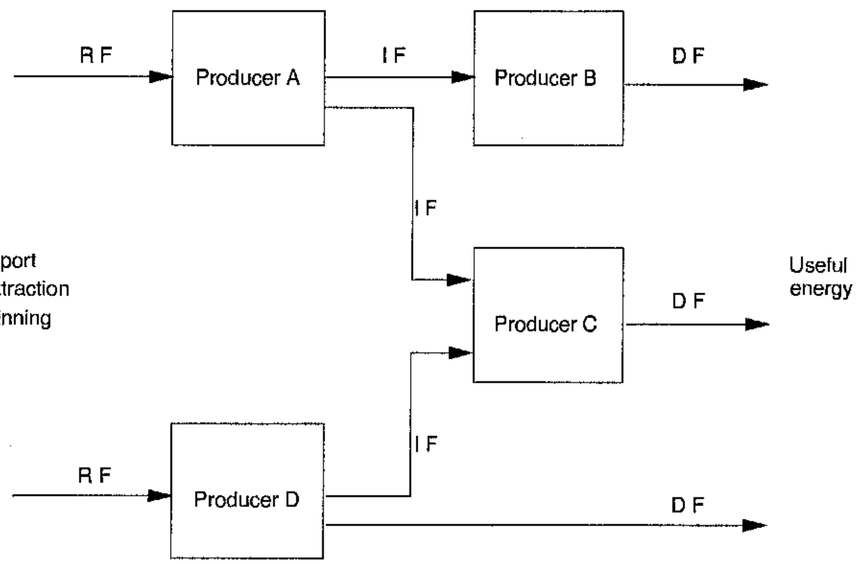

Figure 3.1 *Example of a model with four producers*

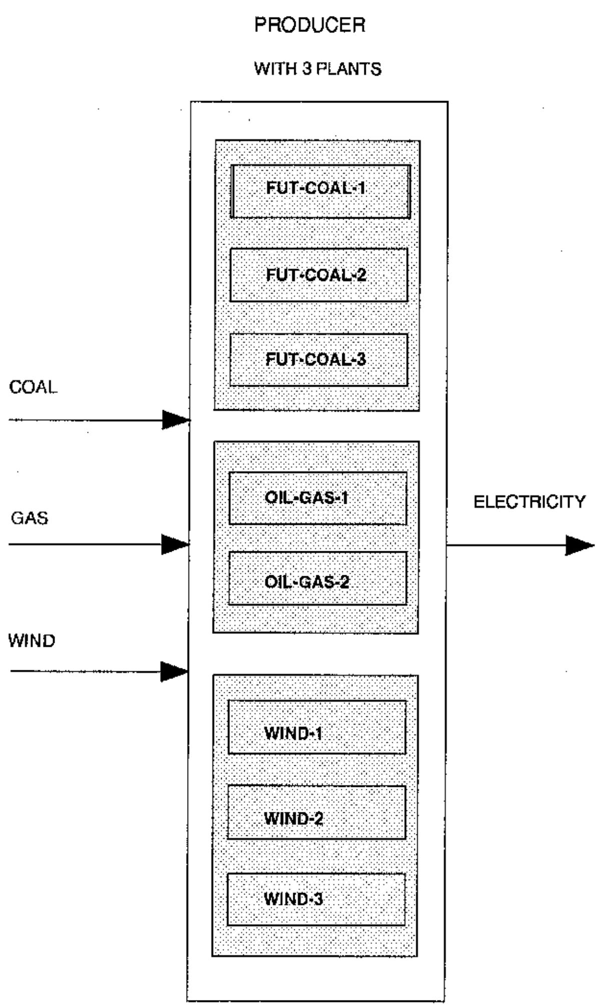

Figure 3.2 *Example of processes for a producer*

SELPE

General

Within the SELPE model the main part is the so called 'producer'. A producer contains one or more processes aggregated in units and plants. Energy flows are defined as source flows from import, extraction etc. to producers (RF), as intermediate flows between producers (IF) and as final deliveries of useful energy from producers to demand (FD). The public electricity production is an example of a producer. In figure 5 the structure of SELPE is given in a simple diagram. A producer contains one or more processes aggregated on two hierarchical levels; plants and units.

As an example a producer is shown with 3 plants (coal, oil, wind) in figure 6. A plant contains one or more units and every unit contains one or more processes.

Process description

Firstly every process in SELPE has a code consisting of 10 characters divided into three parts. The first part indicates the sector, the middle group the type of conversion technology and the last two characters the main fuel as input.

For every process in the data base the fuel and the products are given in detail. Abatement has been assumed for SO_2, NO_x, and aerosols have been supposed.

Technical/economic characteristics

The *unit capacity* is defined on the basis of output in MW. If a process produces electricity the unit is MW_e. If the only product is steam or heat the unit is MW_{th}. The capacity can also appear as PJ per year (coal gasification).

The *efficiency* is the ratio between the sum of the output and the sum of the input. For processes with cogeneration the ratio of produced steam (heat) and produced electricity is given (*H/P ratio*). For lifetime the *economic lifetime* is used. *Availability* is expressed as the fraction of hours that the process operates on maximum capacity in relation to a full year (8760 hours).

The *specific investment* is given in 10^6 DFl_{90} per MW, the investment for the assumed abatement has been included. The *variable costs* are given in 10^6 DFl_{90} per PJ_o, also including abatement.

Use of abatement

For each scenario abatement technologies can be used to reduce the emission levels. The fixed and variable costs related to these technologies are part of the costs of the energy process. Because the penetration of abatement technologies will proceed gradually, the rate of penetration must also be specified.

In the SELPE model 360 different combinations of energy processes and abatement technologies are used, based on:

- 9 main sectors divided in 49 subsectors,
- 84 technologies for the conversion of energy,
- 42 energy carriers as possible input for a technology,
- abatement technologies.

The MOIT data base

Types of collected data

Most of the energy data in Poland is collected by means of questionnaires. Four different types of questionnaire, labelled G-02, G-03, G-09 and G-10, exist in Poland (see figure 2.4).

Questionnaires G-02 and G-03 are common reports filled in by some 10,000 companies using energy for their production process. Questionnaires G-09 and G-10 are prepared by the hard coal mines and the electricity sector companies. A more detailed description of each questionnaire is given below.

G-02 is the Report on Fuels and Energy Carriers Trade, Consumption and Stocks. It is answered by 10,000 companies, industrial, construction, agricultural, trade, transport and by municipal utilities, comprising in total over 80% of national energy consumption. G-02 consists of two sub questionnaires: quarterly G-02a for 15 basic carriers and yearly G-02b for 26 additional carriers.

The questionnaire contains the following data for each energy carrier:
1. Purchases - quantity
2. Purchases - value
3. Sales - quantity
4. Sales - value
5. Opening stocks - quantity
6. Consumption - quantity
7. Closing stocks - quantity.

G-03 contains a more detailed yearly Report on Fuels and Energy Consumption, completed by the same companies as G-02. G-03 contains more detailed calculations of the consumption of 27 energy carriers, including:
- Breakdown of consumption by production of particular goods and services and particular energy transformations, if applicable.
- Data on calorific values of carriers.
- Specific consumption coefficients, useful for energy intensity calculations.

The G-09 questionnaire is a group of 3 reports prepared by hard coal mines, as follows:

G-09.1 Quarterly report concerning Production and Sales of Hard Coal and Hard Coal Briquettes.
G-09.2 Yearly report on Mechanical Processing of Coal.
G-09.3 Yearly report on Mining Damage Repairs.

Finally, the G-10 is a group of 8 reports prepared by electricity sector companies: electricity plants, autoproducers and electricity distribution companies. The successive questionnaires are as follows:

G-10.1	Monthly Report on Electricity and Heat Production, prepared by public thermal power plants.
G-10.2	Yearly, very detailed Report on Public Thermal Power Plants Activities.
G-10.3	Quarterly Report on Electricity Autoproducers Activities,
G-10.4	Monthly Report on Electricity Sales, prepared by electricity distribution companies.
G-10.5	Yearly Report on Electricity Distribution Equipment (overhead and cable lines, transformers etc.).
G-10.6	Yearly Report on Hydro Electric Generation.
G-10.7	Yearly Report on Electricity Flow (flows between distribution companies).
G-10.8	Yearly Report on Electricity Sales (sales breakdown by administrative units and types of consumers).

Summarizing, the information on electricity is collected monthly, the basic consumption and stocks data are known quarterly and there is an annual global picture of the energy sector.

The reports on energy consumption are as yet collected from the companies as a whole unit and not from activity related units or from local units. The hard coal and electricity production data are collected from single plants even if they are formally merged.

General remarks

Statistical energy data are delivered to the MOIT in the dBASE IV format. The attached chart explains the flow of statistical information. In addition to energy data, there are separate modules containing financial data and environmental information. The cost data are expressed in terms of current value Polish Zloty.

The MOIT energy data base is handled by the 'System Energia i Paliwa' program (Energy and Fuels System). This program has been prepared especially for MOIT in parallel with the latest energy statistics modifications. As mentioned above, only the aggregated data are available for persons and institutions outside of MOIT. Access to the specific, detailed data is permitted in special cases and needs to be approved by the MOIT and the President of GUS.

3.3 Standardization of data on energy technologies

In the next table a summary of the process characteristics available for the three energy models is given. The DORSEK and ENPEP data is recalculated on the basis of the ECN definitions. The data provided by MOIT are used to verify the model data with the existing situation.

Table 3.2 *General overview of characteristics (energy)*

	SELPE	ENPEP	DORSEK
Capacity	MW_{th} MW_e PJ/year	1000 BOE/y in case of heat no single plant	not explicitly given
Efficiency	given	given	not explicitly given
Availability	given	min. utility factor	not explicitly given
Heat/Power	given	separate input	not explicitly given
Spec. investment	10^6 DFl_{90}/MW	1000 $/y	10^6 Zl/TCE/a main output
Lifetime	given	given	30 years
Discount rate	5%	10%	12%
O&M	10^6 DFl_{90}/PJ_o	$/BOE	10^6 Zl/TCE main output
SO_2, NO_x, part.	tons/PJ_i	tons/PJ_i	tons/TCE main output

Table 3.3 *General overview of characteristics (abatement)*

	SELPE	ENPEP	DORSEK
Energy input	n.a.	n.a.	given
Spec. investment	10^6 DFl_{90}/MW	US$/$GJ_i$	10^6 Zl/TCE main output
O&M	10^6 DFl_{90}/PJ_o	US$/$GJ_i$	10^6 Zl/TCE main output
SO_2, NO_x, part.	tons/PJ_i	%	tons/TCE

General remarks

In order to make a reasonable comparison between the conversion processes in different databases (DORSEK, ENPEP, SELPE) a number of assumptions have been made.

SELPE/NEV

In SELPE the process data consists of a combination of the base case data and the data of the abatement technology linked to the base case. The result depends on the environmental assumptions in the scenario and that is the reason why the process data of the unabated case is given for SELPE.

Before the process data is inputed to the SELPE model the data of the base case, the case without abatement technologies, is changed to take account of the environmental measures which are included in the scenario.

Processes of the same type with the same specific investment are considered as equal and therefore the data of two processes sometimes appear in the list, one for the small capacity and one for the larger capacity.

The processes using coal as fuel are considered to be AFBC boilers with high pressure steam (for more details see the reports on Industrial Heat & Power, an economic accounting framework, ECN-I--91-072, and Investeringen WKK, actualisering data bases, ECN-C--91-084).

The data in the database do not agree with the data in the most recent report. The first report provides further information, see Appendices 'Explanation of input'. The reason for this discrepancy is unknown. Where necessary the most recent data will be used in the analysis. In the second report a accurate specification of the different costs has been given. The existing processes in the Netherlands are of a conventional type.

A distinction is made between heavy oil with a large sulphur content (1.85%) and a lighter oil with 1% sulphur for oil products as fuel.

A number of processes use a secondary gas as fuel viz. blast furnace gas, industrial gas and chemical gas. The SELPE model data base also includes a number of advanced technologies which are still under development but which may be used in the future (for example fuel cells). These technologies are given in a separate list.

Groups of processes

The processes of the three databases are grouped by product and by fuel in order to compare the characteristics given in the data bases of the three models. The groups distinghuished in Appendix A are:

- Public Power Plants — Coal (different types of coal LC/HC)
Lignite (production with small amount of heat)
Gas (peak power GT)
Oil (DORSEK, ENPEP), oil/gas for SELPE
Uranium
Miscellaneous (hydro, pumped storage, wind)
- Cogeneration — Coal
- Industry and public — Gas (natural and other secondary)
Oil
Other primary (woodwaste etc.)
- Heat Industry — Coal
Coke
Gas
Oil
Other primary/secondary
- Municipal — Coal (lumps)
Coke
Gas
Oil
Other (biomass, renewables)
- Coal gasification — Lurgi etc.
Town gas
Gas generators
Low temperature carbonization
- Coke plant — Metallurgic coal
- Extraction — Oil
Gas
- Mines — Mining
Briquetting
Coal beneficiation
- Refineries — Refineries
Gasification of oil residuals
- Substitution — Dummies

Another group is the abatement for SO_2, NO_x and particulates.

4. COMPARISON OF DATA BASES

4.1 Comparison of energy technologies

For the comparison of energy technologies the following aspects have been taken into account:

- new or existing process;
- the type of fuel, including calorific value and sulphur content;
- the type of process, conventional, (A)FBC, IGCC etc.;
- capacity of the process;
- use factor (important for the recalculation of data);
- production ratio between heat and power (H/P) (also determined by the type of process);
- the variable costs (O&M) do not contain fuel costs.

The first step was to standardise the data in the three data bases. The format of the data of the ENPEP and DORSEK-E models was adapted to the data of the SELPE model. The standardized data for the conversion and production processes are given in Appendix A and for the abatement processes in Appendix B.

Many processes in the DORSEK model are distinguished on the basis of different types of fuels. This makes a direct comparison difficult and therefore a SELPE process was taken as a reference, and similar processes from DORSEK and ENPEP were compared with the SELPE process. The processes have been grouped according to the list in Chapter 3.3.

4.1.1 Public power plants

Coal

Existing plants

In the Polish situation different types of hard coal can be used having their own calorific value and sulphur content. A direct comparison is therefore not possible. The conversion efficiency of the Polish power plants ranges from 0.26 to 0.29 compared with approximately .40 for Dutch power plants. The use factors applied in SELPE and DORSEK are almost the same (0.60) but the factors in the ENPEP model are higher viz. 0.70. For the existing plants no data is given on investment. Data on operation and maintenance costs differ considerably between the data bases and there are also differences in the emission factors of SO_2, NO_x and Particulates.

New plants

The data used for new systems are shown in Table 4.1. For this comparison the ENPEP data were used as the reference because these data also include abatement technologies.

Table 4.1 *Process characteristics coal power plants*

Parameters		SELPE	DORSEK	ENPEP
Type		600 MW_e, 1.4 %S ECV-CO2-CL	LCV 1.5 %S ELMN15	500MW_e, LWP97, ECT
Efficiency		0.40	0.31	0.29
Use factor		0.61	0.74	0.70
Spec. investm.	DFl/kW_e	1798 ---> 2029	1522 ---> 1800	1646
O&M	DFl/GJ_o	1.753 ---> 3.800	2.130 ---> 3.000	4.20
SO_2	tons/PJ_i	960 ---> 88	1085 ---> 55	90
NO_x	tons/PJ_i	280 ---> 145	149	130
CO_2	ktons/PJ_i	94	82	92
Particulates	tons/PJ_i	99 ---> 4	97	10

Because Fluidized Bed Combustion is only an option in the DORSEK model this technology cannot be compared.

An option for public power supply is to produce electricity by means of coal gasification. The characteristics of this technology are included in the DORSEK and SELPE models. The table in Appendix A shows that the emissions factors and the investment costs are almost the same. However, differences are seen in the efficiency and use factor. For the O&M costs, the differences ranges from 4.7 DFl/GJ_o for SELPE to 2.4 DFl/GJ_o for DORSEK.

Lignite

In the Netherlands LIGNITE is not used as fuel so there can only be a comparison between data used in the two Polish models. It is clear from the tables in Appendix A that the data differ for the two models. For DORSEK a more general approach is used while in ENPEP special units are defined because ENPEP treats each unit separately.

Gas

In this case a distinction is made between a conventional unit, a gas turbine used for the production during peakload and a combined cycle unit. Only new units will be discussed. Table 4.2 gives data on gas turbines and Table 4.3 gives information on Combined Cycle systems

Table 4.2 *Process characteristics gas turbines*

Parameters	Dimension	SELPE	DORSEK	ENPEP
Type		25 MW_e ECV-PGT-GN	ELSGAZ	50 MW_e 37 N
Efficiency		0.35	0.25	0.30
Use factor		0.03	?	0.18
Spec. investm.	DFl/kW_e	1150	3391	568
O&M	DFl/GJ_o	16.00	14.25	1.75
SO_2	tons/PJ_i	0	0	0
NO_x	tons/PJ_i	179	138	172
CO_2	ktons/PJ_i	56	29	50
Particulates	tons/PJ_i	0	0	6

The emission coefficient for particulates applied in the ENPEP model is doubtful. The use factor for the SELPE model is very low because gas turbines are only used during periods of extremely high peakload. The ENPEP data are very low in comparison with the other data.

Table 4.3 *Process characteristics combined cycle*

Parameters		SELPE	DORSEK	ENPEP
Type		220 MW_e ECV-STN-GN	ELPGGZ	160 MW_e 70 N
Efficiency		0.52	0.43	0.400
Use factor		0.61	0.74	0.75
Spec. investm.	DFl/kW_e	1248	728	1010
O&M	DFl/GJ_o	1.400	1.110	2.530
SO_2	tons/PJ_i	0	0	0
NO_x	tons/PJ_i	230	76	172
CO_2	ktons/PJ_i	56	49	50
Particulates	tons/PJ_i	0	0	6

As expected, the efficiency in SELPE is higher than in the Polish models. The reason for the low costs and low NO_x emission factor applied in the DORSEK model is not clear.

Oil

In the Netherlands fuel oil is only used for the starting-up procedure. In DORSEK and ENPEP models oil fired units are included. As shown in Appendix A large differences between the data exist. In the SELPE model new technology is included: the integrated system of oil gasification combined with electricity production. In the most advanced system there is also the possibility to store the CO_2 in depleted gasfields.

Uranium

The data given for specific investment of nuclear power plants for the SELPE model (3.75 and 4.5 million Dutch guilders) are significantly higher than those used in DORSEK (2.60 and 2.34 million Dutch guilders) and ENPEP (2.34 million Dutch guilders). Also the O&M costs are higher. In the specific investment about 13% is used as a reserve for decommissioning and in the O&M costs a significant portion is set aside for waste disposal. In SELPE two different plants are assumed. The first is a reactor used in Germany but adjusted to more stringent safety requirements. It is expected that the design of this type of nuclear plant will be available in 1994. The second is a reactor design primarily based on passive safety.

Hydro

For hydropower plants data have only been given for SELPE and ENPEP. It is very difficult to compare these data because the geographical situations are so different.

4.1.2 Public cogeneration

Coal

There are two types of conversion processes included in the comparison, namely fluidized bed boilers and a combination of boiler and backpressure turbine. The ENPEP data are given in two parts because of the structure of the model.

The existing processes in DORSEK have higher H/P ratios than SELPE, whereas newer processes have smaller ratios. The investment per MW_e in DORSEK seems smaller than for the SELPE data but taking into account the difference in H/P ratio and the lower efficiency for the DORSEK process, the investments cost per unit of electricity produced will be the same. The O&M costs are almost the same.

The data on Fluidized Bed Combustion are comparable for DORSEK and SELPE.

4.1.3 Industrial cogeneration

Coal

In this sector (Atmospheric) Fluidized Bed Boilers are included as new processes. The H/P ratio is about 4.3 in DORSEK and 7.3 in SELPE which explains the difference in specific investment. In the calculation of the specific investment for the DORSEK data the use factor plays an important role. If the factor is low, production needs more power but the total investment was fixed so that the specific investment will be lower. Considering these point leads to the conclusion that the DORSEK and ENPEP data does not really differ. This is also the case for conventional technology.

4.1.4 Heat production

Industry coal, gas, oil and other fuel

In the Netherlands coal fired boilers are rarely used in industry which means that only few data are given in the Appendix. In the ENPEP data base no data are included for this sector because it has not yet been collected.

4.1.5 Conversion

Coal Gasification

Only the SELPE and DORSEK models include processes describing the gasification of coal. The SELPE data base contains three different processes for coal gasification, underground coal gasification and gasification of oil.

In general, the investment costs for these technologies are lower in the SELPE model compared to DORSEK model.

Specific processes for the local production of gas from coal are only available for the DORSEK model.

Refinery

Within the SELPE model only one refinery process is defined, but for this sector a specific sector model called SERUM is used. Within the SERUM model three types of refineries are distinguished. The data base associated with the SERUM model is given in Appendix C.

4.1.6 Miscellaneous

Extraction of Oil

Two processes are defined within the SELPE model for the extraction of crude oil, namely onshore and offshore exploitation but only the onshore production is taken into account for the comparison. In SELPE the O&M costs are 5.1 DFl/GJ_o compared to 1.47 DFl/GJ_o in the DORSEK model. In ENPEP no data are given for this process.

Extraction of Natural Gas

In SELPE the O&M costs for the production of gas onshore is set at 0.63 DFl/GJ_o. These data are almost the same as the DORSEK data. The data used in ENPEP are much higher.

Mining

Data on mining is only available in the Polish data bases because there are no productive coal mines in the Netherlands. The data from DORSEK and ENPEP differ considerably.

Briquetting

Only Polish data are available and these do not differ very much except the O&M costs for coal in ENPEP which is relatively high.

Coal beneficiation

These processes are only defined in the DORSEK model.

4.2 Comparison of abatement technologies

Information stored in the three data bases about abatement technologies are given in Appendix B. In this section the differences between the data bases are evaluated.

4.2.1 SO_2 emissions

In Appendix B the data are given on the abatement technologies for reducing the emission of SO_2. Each abatement technology is related to an energy process. Below, the data will be discussed by sector and by energy process.

Public power plants

In the DORSEK model at least one abatement technology is associated to each energy process. Table 4.4 presents an overview of energy processes and abatement technology for the various models.

Table 4.4 *Process characteristics of abatement technologies for SO_2*

Fuel	Model	Type	%	Investment	O&M
Coal	DORSEK	SD	85	0.23-0.27	0.63-0.83
		WET	95	0.28-0.33	0.91-0.94
		LIFAC	70	-0.17	-0.42
	ENPEP	WET	90	0.30-0.40	0.20-0.20
	SELPE	WET	85	0.19-0.25	1.90-2.06
Lignite	DORSEK	DRY	35	0.05-0.05	0.19-0.19
		WET	95	0.26-0.31	0.85-0.99
Oil	DORSEK	WET	90	0.28-0.33	0.84-0.84
	SELPE	WET	85	0.19-0.25	1.72-2.06

The wet scrubbing option is included in all three models. The efficiency is different but the specific investment is about the same. The O&M costs in SELPE are significantly higher. In the case where fuel oil is used the O&M costs are similar. In SELPE a more general option is the use of AFBC boilers. Also better optimized systems are available with higher O&M costs and a decrease in SO_2 emission of about 20-60 t/PJ_i.

Cogeneration

For cogeneration the SELPE model also includes the option to use AFBC boilers. In the ENPEP model no options are available and the options in DORSEK are very specific.

Heat production

Heat production takes place in industry and in municipal heating. There are three options to reduce the emission of SO_2, namely limestone injection into the oven, dry scrubbing and wet scrubbing.

4.2.2 NO_x emissions

Public power plants

For the abatement of NO_x two main options can be distinguished, namely selective catalytic reduction and an option called 'primary measures'. For the last option the burner and the method of combustion are modified in a such a way that less NO_x will be released into the atmosphere. The use of SCR in existing plants will cost more. Of particular note is the high O&M cost used in ENPEP (2.55) and SELPE(1.99) in contrast to DORSEK (about 0.85).

Cogeneration

A number of abatement technologies are associated with cogeneration. The investment costs for SCR in the SELPE model is twice that in the DORSEK model; the variable costs are almost the same.

Heat production

In DORSEK the only option is the primary measurements. In SELPE there are different options that can be seen as primary options but also selective catalytic reduction is assumed.

4.2.3 Particulate emissions

Public power plants

For the reduction of the emission of particulates in DORSEK and SELPE electric precipatators are the only options but in ENPEP cyclone and baghouse are also available.

Cogeneration

Currently ENPEP has no options for this type of energy processes. In SELPE additional options are available while the DORSEK model has the precipitator as main option.

Heat production

In this group of processes it is the same as in cogeneration

5. CONCLUSIONS AND RECOMMENDATIONS

The availability of a data base containing accurate information on a large number of variables is essential to any energy planning study. The results of the computer model calculations depend on the reliability of this information.

The design of a data base depends heavily on the specific requirements of the model related to the data base. This means that the same information can be stored in a different format. Before any comparison between data bases can be made the formats should firstly be reduced to the same denominator and once the format is the same a comparison for each technology of all the characteristics can be performed.

Many differences exist between the Polish and Dutch data bases. In a number of cases the reasons for these differences are clear: differences in definition of the technology; a different method of application of the technology or different assumptions about prices and costs. In other cases a much more detailed analysis of the data is necessary in order to explain satisfactorily the reasons for the differences.

Another result of the study concerns the exchange of data on advanced future technologies, such as fuel cells and nuclear energy. The Dutch data base contains a number of these technologies which are not present in the Polish data bases. This also applies to technologies intended to reduce the emissions released into the atmosphere, in particular the economic data related to these technologies. These technologies are placed at the disposal of the Polish energy institutes (Appendix B) together with a list of technologies and associated characteristics used in the refinery sector.

One of the side effects of the examination of the data bases was that the way in which the energy sector is mathematically described by the three energy models has also been reviewed. In particular, the technology of combined heat and power is modelled differently and modifications in this respect were recommended. This subject is analysed in more detail in a separate study defined by the Task Force (Volume III: A Comparison of the energy models DORSEK-E, ENPEP and EFOM).

Summarizing, the main conclusion of this study is that the comparison of the contents of Polish and Dutch data bases proved to be a very useful activity. The detailed evaluation of the data which was required in order to perform the comparison, also yielded new insights concerning which type of data is missing, the appropriate level of detail and the role of the MOIT data base with regard to energy statistical information in Poland.

Many differences exist between the Polish and Dutch data bases which, due to the limited time available for this study, could only partly be explained. Therefore, it is recommended to continue this activity and to extend the comparison with a review of the different data base systems used by the institutes.

APPENDIX A: ENERGY CONVERSION PROCESSES

CONTENTS

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

PUBLIC POWERPLANTS **COAL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ$_o$	SO_2	NO_x (k)	CO_2 tons/PJ$_i$	Part.
SELPE												
ECV-CO1-CL			600 MWe		0.40	0.61	1.547	1.678	960	300	94	99
ECV-CO2-CL			600 MWe		0.40	0.61	1.798	1.753	960	280	94	99
ECV-COG-CL		IGCC	600 MWe		0.42	0.61	2.260	4.700	30	190	94	1
ECV-COV-CL		IGCC	514 MWe		0.36	0.61	3.290	6.920	10	190	11	1
DORSEK												
ELFE15 N	LCV-1.5	FB			0.32	0.74	1.884	3.15	165	68	80	70
ELFE20 N	LCV-2.0	FB			0.32	0.74	1.884	3.11	358	68	80	99
ELMN10 N	LCV-1.0				0.31	0.74	1.522	2.18	801	149	82	94
ELMN15 N	LCV-1.5				0.31	0.74	1.522	2.13	1085	149	82	97
ELMN20 N	LCV-2.0				0.31	0.74	1.522	1.89	2320	149	82	110
ELMW10 N	HCV-1.0-				0.32	0.74	1.447	2.07	719	150	82	48
EPGZW2 N	CL-2.0	IGCC			0.39	0.74	2.175	2.44	25	99	80	13
EPGZW5 N	CL-1.5	IGCC			0.39	0.74	2.175	2.44	25	99	80	13
ELZN10 E	LCV-1.0				0.29	0.60		2.05	754	241	78	304
ELZN15 E	LCV-1.5				0.29	0.60		2.00	1029	241	78	312
ELZN20 E	LCV-2.0				0.29	0.60		1.74	2229	241	78	354
ELZW10 E	HCV-1.0				0.31	0.60		1.97	686	245	79	157

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

PUBLIC POWERPLANTS **COAL (continued)**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
ENPEP												
26 N ECT	Coal		360 MWe		0.33	0.72	1.101	2.61	1025	270	91	330
26 N ECT	Coal	Protected LWP97	360 MWe		0.33	0.72	1.592	5.20	100	130	91	10
31 N ECT	Coal		500 MWe		0.29	0.70	1.092	2.38	920	270	92	330
31 N ECT	Coal	Protected LWP97	500 MWe		0.29	0.70	1.646	4.20	90	130	92	10
1 E ECD	Coal HCV - 0.5	PPR	50 MWe		0.26	0.75		2.09	470	430	91	165
4 E ECD	Coal LCV - 1.0	nihil	50 MWe		0.26	0.75		2.09	1060	610	91	1600
6 E ECW	Coal LCV - 1.2	PPR	50 MWe		0.26	0.75		2.09	1065	550	97	174
13 E ECD	Coal LCV - 1.5	PPR	100 MWe		0.29	0.70		2.03	1822	570	91	740
16 E ECD	Coal LCV - 1.0	PPR	120 MWe		0.30	0.70		1.93	1150	617	91	240
19 E ECD	Coal LCV - 2.5	PPR	120 MWe		0.30	0.70		1.93	2870	515	97	160
2A E ECD	Coal LCV - 2.0	PPR	200 MWe		0.34	0.68		2.29	2200	656	97	807
2B E ECD	Coal LCV - 1.5	PPR	200 MWe		0.34	0.68		2.29	1920	656	97	140
2C E ECD	Coal LCV - 1.0	PPR	200 MWe		0.34	0.68		2.29	1025	615	97	440
22 E ECD	Coal LCV - 1.5	PPR	200 MWe		0.34	0.68		2.29	1420	551	97	290
60 E ECT	Coal LCV - 1.0	LWP97	500 MWe		0.34	0.70		2.26	920	560	91	290
MOIT												
E	Coal		120 MWe			0.58/0.59						
E	Coal		200 MWe			0.64/0.68						
E	Coal		500 MWe			0.24						

PUBLIC POWERPLANTS **LIGNITE**

Code	Fuel	Type		Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
DORSEK													
ELWB06 N	LIG-0.6					0.30	0.74	1.594	1.89	1030	130	86	68
ELWB12 N	LIG-1.2					0.30	0.74	1.594	1.65	2269	130	86	71
ELZB06 E	LIGN-0.6					0.28	0.68		1.80	1008	177	84	417
ELZB12 E	LIGN-1.2					0.28	0.68		1.55	2219	177	84	433
ENPEP													
55 N	LIGN			200 MWe		0.30	0.70	1.150	2.98	1010	260	100	120
55 N	LIGN	Prot	LWP	200 MWe		0.30	0.70	1.660	4.37	100	130	100	10
50 N	LIGN			500 MWe		0.28	0.70	1.119	2.38	1000	260	120	100
55 N	LIGN	Prot	LWP	500 MWe		0.28	0.70	1.590	3.77	100	130	100	10
44 E	LIGN	PPR	PWS97	50 MWe		0.26	0.74		2.17	1120	400	100	490
48 E-MOD	LIGN		LWP	120 MWe		0.29	0.70		1.33	110	150	100	120
49 E	LIGN		PWS	200 MWe		0.31	0.70		1.73	1070	260	100	490
69 E	LIGN	Belch.	PWS	360 MWe		0.33	0.70		1.50	1420	260	100	100
MOIT													
E	LIGN			120 MWe		0.63							
E	LIGN			200 MWe		0.77							
E	LIGN			360 MWe		0.76/0.78							

PUBLIC POWER PLANTS **GAS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^5 Dfl/MWe	O&M Dfl/GJ$_o$	SO_2	NO_x (k)	CO_2 tons/PJ$_i$	Part.
SELPE												
ECV-CO2-GN		Modern (DF)	600 MWe		0.40	0.61	2.016	3.800	0	179	56	0
ECV-PGT-GN		Gasturbine	25 MWe		0.35	0.03	1.150	16.000	0	230	56	0
ECV-SCO-GN		GT before	300 MWe		0.46	0.31	1.450	3.000	0	105	56	0
ECV-STG-GN		Combined Cycle	300 MWe		0.46	0.20	1.413	2.948	0	230	56	0
ECV-STN-GN		Combined Cycle	220 MWe		0.52	0.61	1.248	1.400	0	230	56	0
ECV-STV-GN		Combined Cycle	548 MWe		0.42	0.61	2.110	3.740	0	200	7	0
ECV-OGA-GB		Conventional	300 MWe		0.38	0.70	1.400	1.400	26	67	175	0
ECV-OGA-GN		Conventional	300 MWe		0.40	0.13	1.330	2.800	0	140	56	0
DORSEK												
ELPGGZ N	Gas	Combined Cycle			0.43	0.74	0.728	1.11	0	76	49	0
ELSGAZ N	Gas	Gasturbine			0.25	0.74	3.391	14.25	0	138	29	0
ELZGZI E	Gas				0.31	0.63		1.11	0	73	47	0
ENPEP												
37 N		Gasturbine	50 MWe		0.30	0.18	0.568	1.75	0	172	6	50
70 N		Combined Cycle	160 MWe		0.40	0.75	1.010	2.53	0	172	6	50

PUBLIC POWER PLANTS OIL

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ECV-OGA-OS			300 MWe		0.40	0.13	1.080	0.737	765	180	77	20
ECV-CO1-OH			600 MWe		0.40	0.61	1.606	2.079	766	196	77	20
ECV-OIG-OH		IGCC	600 MWe		0.44	0.61	1.560	2.300	30	200	77	1
ECV-OIV-OH		IGCC	532 MWe		0.39	0.61	2.320	3.900	10	200	9	1
DORSEK												
ELOLON N	HFO-1.2				0.33	0.74	1.101	1.42	508	103	66	13
ELOLOP N	HFO-2.5				0.33	0.74	1.101	1.35	1059	103	66	13
ELZOLN E	HFO-1.2				0.31	0.63		1.38	504	204	65	13
ELZOLO E	HFO-2.5				0.31	0.63		1.32	1050	204	65	13
ENPEP												
36 E	OIL		200 MWe		0.34	0.60		0.75	1320	490	77	6

PUBLIC POWER PLANTS **URANIUM**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ECV-NUC-UR			1000 MWe		0.34	0.71	3.750	3.00	0	0	0	0
ECV-NUS-UR			600 MWe		0.34	0.71	4.500	8.40	0	0	0	0
DORSEK												
ELJLWR N	NUC				0.30	0.74	2.595	2.78	0	0	0	0
ENPEP												
59,60 N	NUC		1000 Mwe		0.34	0.68	2.34	2.86	0	0	0	0

PUBLIC POWER PLANTS **HYDRO**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
EPR-HYD-RH			10 MWe			0.56	5.000	7.00				
EST-PAU-EL		Pumped Acc. Unit	5 MWe		0.76	0.50	2.000	0.00				
ENPEP												
3 N		Hydro-pumped	571 MWe			0.25	1.218	8.8				
5 N		Hydro-pumped	533 MWe			0.25	1.280	8.8				
7 N		Hydro-pumped	466 MWe			0.25	1.690	8.8				
1 E		Hydro-pumped	1375 MWe			0.16		13.2				
4 N		Hydro	125 MWe			0.25	2.997	0.5				
60 N		Hydro	155 MWe			0.49	3.759	0.3				
8 N		Hydro	121 MWe			0.49	3.739	0.3				
2 E		Hydro	151 MWe			0.25		0.5				

PUBLIC POWER PLANTS **FUTURE OPTIONS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ECV-FUC-GH		Fuelcells	3 MWe		0.52	0.69	2.500	14.043	0	1	0	0
ECV-FUC-GN		Fuelcells	3 MWe		0.52	0.69	2.500	14.043	0	1	56	0
EPR-SOC-RS		PV-cells	1 MWe			0.11	2.00	11.00	0	0	0	0
EPR-WI1-RW		Windturbine	1.8 MWe			0.26	2.26	5.68	0	0	0	0
EPR-WI2-RW		Windturbine	0.29 MWe			0.26	2.03	5.10	0	0	0	0
EPR-WI3-RW		Windturbine	1.35 MWe			0.26	1.52	3.83	0	0	0	0
EPR-WI4-RW		Windturbine	3.6 MWe			0.31	3.00	8.00	0	0	0	0

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

PUBLIC COGENERATION **COAL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
EHP-CBP-CL	1.2 % S		20 MWe	4.9	0.85	0.59	6.269	1.798	846	330	94	100
EHP-CBP-CL		FBC	20 MWe	4.9	0.85	0.59	6.75	3.157	253	82	94	13
DORSEK												
ECFN10 N	LCV-1.0	FBC		2.8	0.71	0.55	4.682	2.60	138	73	91	15
ECFN15 N	LCV-1.5	FBC		2.8	0.71	0.55	4.682	2.60	188	73	91	17
ECMN07 N	LCV-0.7			2.8	0.73	0.55	4.073	1.97	604	165	91	11
ECMN10 N	LCV-1.0			2.8	0.73	0.55	4.073	1.93	884	165	91	11
ECMW07 N	HCV-0.7			2.7	0.76	0.55	3.742	1.97	475	165	91	15
ECMW10 N	HCV-1.0			2.7	0.76	0.55	3.742	1.92	790	165	91	16
ELCZN7 E	LCV-0.7			8.0	0.68	0.46		2.20	626	286	92	1250
ELCZN1 E	LCV-1.0			8.0	0.69	0.46		2.18	902	286	92	1242
ELCZN5 E	LCV-1.5			8.0	0.69	0.46		2.17	1221	286	92	1275
ELCZW1 E	HCV-0.7			7.6	0.73	0.46		1.98	815	288	93	633
ELCZW7 E	HCV-1.0			7.6	0.73	0.46		2.02	503	288	93	598
ENPEP												
42 E	COAL ACV 0.9		30 MWe		0.48	0.68		2.5	1231	573	91	450
46 E	COAL ACV 0.9		60 MWt		0.70	0.30		2.6	1231	573	91	450
47 E	LCV-1.0		60 MWt		0.70	0.25		2.6	1300	583	91	702
50 E	LIGNITE		70 MWt		0.70	0.23		1.5	1100	260	100	360

PUBLIC COGENERATION **GAS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
EHP-CBP-GN			20 MWe	4.9	0.78	0.59	4.968	2.000	0	100	56	0
EHP-CSG-GN			25 MWe	1.1	0.85	0.59	1.365	1.524	0	230	56	0
EPH-CSG-GN			250 MWe	0.7	0.80	0.59	1.341	1.700	0	230	56	0
DORSEK												
ECZGZI N	Natural Gas			2.6	0.80	0.55	2.218	1.23	0	82	54	0
ELCZGZ E	Natural Gas			6.7	0.79	0.46		1.42	0	82	53	0

PUBLIC COGENERATION OIL

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
EHP-CTE-OM			25 MWe	1.1	0.82	0.59	1.230	0.197	116	1207	73	20
EHP-CBP-OS			20 MWe	4.9	0.78	0.59	4.960	1.900	908	150	77	15
DORSEK												
ECZOLN N	HFO-1.2			2.6	0.82	0.55	2.282	1.53	574	116	74	15
ECZOLO N	HFO-2.5			2.6	0.82	0.55	2.282	1.53	1197	116	75	15
ELCZON E	HFO-1.2			7.3	0.78	0.46		1.76	572	232	74	16
ELCZOL E	HFO-2.5			7.3	0.78	0.46		1.80	1191	232	74	16

PUBLIC COGENERATION **WASTE**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
EHP-INC-WI			40 MWe	1.4	0.44	0.56	2.000	12.250	80	150	90	35

INDUSTRIAL COGENERATION **COAL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
<u>SELPE</u>												
EHP-CBP-CL	CL		20 MWe	7.3	0.85	0.59	6.269	1.798	846	330	94	100
OUT-CBP-CL	CL		10 MWe	7.3	0.87	0.70	6.709	0.945	846	330	94	101
I.L-CBP-CL	CL		5-10 MWe	7.3	0.87	0.69	6.801	1.131	846	330	94	13
I.L-CBP-CL	CL	AFBC	5-10 MWe	7.3	0.87	0.69	7.293	2.317	253	82	94	13
I.S-CBP-CL	CL		3-6 MWe	7.3	0.87	0.69	9.246	2.171	846	330	94	13
I.S-CBP-CL	CL	AFBC	3-6 MWe	7.3	0.87	0.69	9.739	3.357	253	82	94	13
<u>DORSEK</u>												
ECPF10 N	LCV-1.0	FBC		4.3	0.75	0.37	3.829	3.89	141	74	93	18
ECPF15 N	LCV-1.5	FBC		4.3	0.75	0.37	3.829	3.89	192	74	93	19
ECPN10 N	LCV-1.0			4.3	0.75	0.37	3.331	2.95	899	104	93	18
ECPW07 N	HCV-0.7			4.1	0.76	0.37	3.056	2.46	483	101	93	19
ECPW10 N	HCV-1.0			4.1	0.76	0.37	3.056	2.44	804	101	93	20
ELCPN1 E	LCV-1.0			12.6	0.66	0.32		3.33	960	198	98	1097
ELCPN5 E	LCV-1.5			12.6	0.66	0.32		3.31	1289	198	98	1127
ELCPW7 E	HCV-0.7			11.9	0.69	0.32		2.78	548	199	98	522
ELCPW1 E	HCV-1.0			11.9	0.69	0.32		2.80	868	199	98	522

INDUSTRIAL COGENERATION **GAS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_1	Part.
SELPE												
EHP-CBP-GN	GN		20 MWe	6.7	0.78	0.59	4.968	2.000	0	100	56	0
OUT-CBP-GN	GN		10 MWe	6.7	0.91	0.70	2.797	0.910	1463	100	56	0
I.L-CBP-GN	GN		5-10 MWe	6.7	0.91	0.70	2.791	0.910	0	100	56	0
I.S-CBP-GN	GN		3-6 MWe	6.7	0.91	0.61	4.000	1.300	0	100	56	0
DORSEK												
ECPGZIN	GN			3.8	0.83	0.37	1.412	1.65	0	50	54	0
ELCPGZE	GN			10.2	0.76	0.32		1.91	0	84	54	0

INDUSTRIAL COGENERATION **OIL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
OUT-CBP-OH	OH 1.85 S		10 MWe	6.7	0.91	0.70	3.325	0.980	1463	160	77	15
OUT-CBP-OS	OS 1.0 S		10 MWe	6.7	0.91	0.70	3.325	0.980	1463	160	77	15
I.L-CBP-OS	OS 1.0 S		5-10 MWe	6.7	0.91	0.65	3.320	0.980	908	160	77	15
ICH-CBP-OS	OS 1.0 S		10 MWe	6.7	0.91	0.65	3.340	0.980	908	160	77	15
I.S-CBP-OS	OS 1.0 S		3-6 MWe	6.7	0.91	0.61	4.760	1.450	908	160	77	15
EHP-CBP-OS	OS 1.0 S		20 MWe	6.7	0.78	0.59	4.960	1.900	908	150	77	15
DORSEK												
ECPOLN N	OH 1.2 S			3.9	0.82	0.37	1.639	2.09	292	89	75	19
ECPOLO N	OH 2.5 S			3.9	0.82	0.37	1.639	2.09	608	89	75	19
ELCPOL E	OH 2.5 S			10.5	0.73	0.32		2.36	1216	167	75	16
ELCPON E	OH 1.2 S			10.5	0.73	0.32		2.38	584	167	75	16

INDUSTRIAL COGENERATION **OTHER FUEL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
IPE-CBP-GR	Refinerygas		10 MWe	6.7	0.91	0.70	2.759	0.900	10	159	56	7
OUT-CBP-GR	Refinerygas		10 MWe	6.7	0.91	0.70	2.791	0.900	21	119	56	7
IIS-CBP-GB	Blastfurn.gas		5 MWe	6.7	0.91	0.65	2.823	0.910	30	38	270	0
IIS-CBP-GC	Chemicalgas		5 MWe	6.7	0.91	0.65	2.783	0.910	200	105	47	0
IPE-CBP-GI	Industrialgas		10 MWe	6.7	0.91	0.70	2.779	0.900	22	80	55	8
DORSEK												
ECPPO1 N	Other. prim.			4.1	0.72	0.37	3.400	2.71	795	392	374	4
ECPPO2 N	Other. sec.			4.1	0.72	0.37	3.400	2.71	795	392	374	4
ELCPO1 E	Other. prim.			10.5	0.68	0.32		3.09	163	101	95	103
ELCPO2 E	Other. sec.			10.5	0.68	0.32		3.09	163	101	95	103

INDUSTRIAL COGENERATION *OTHER TECHNIQUES in SELPE*

Code	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	Emission ton/PJ_i NO_x (k)	CO_2 tons/PJ_i	Part.
I..-CFH-GN	Fuelcells before dryer/heater	3.000 MWe	1.0-1.5	0.820	0.639	2.400	7.339	0	8	56	0
I..-CFS-GN	Fuelcells with boiler	3.000 MWe	0.8-0.7	0.812	0.639	2.500	8.188	0	7	56	0
OUT-CFS-GR		3.000 MWe	0.8-0.7	0.812	0.639	2.500	8.188	0	7	56	0
IFE-CGD-GN	Gasturbine before dryer	5.000 MWe	10.1	0.900	0.700	2.400	0.400	0	65	56	0
OUT-CGF-GN	Gasturbine before furnace	14.000 MWe	4.0	0.900	0.74	2.400	0.390	1463	138	56	0
OUT-CGF-GR		14.000 MWe	4.0	0.900	0.74	2.400	0.390	21	152	56	7
I..-CGH-GN	Gasturbine before heater	5.000 MWe	10.1	0.900	0.700	2.400	0.400	0	65	56	0
OUT-CGT-GN		25.000 MWe	2.3	0.840	0.740	1.196	0.583	1463	230	56	0
OUT-CGT-GR		25.000 MWe	2.3	0.840	0.740	1.196	0.583	21	253	56	7
ICH-CGT-GN	Gast.with wasteheatboiler	16.000 MWe	2.3	0.840	0.700	1.202	0.556	0	230	56	0
IPE-CGT-GI	with possib. for co-firing	20.000 MWe	2.3	0.840	0.700	1.202	0.546	22	253	56	8
IPE-CGT-GR		20.000 MWe	2.3	0.840	0.700	1.202	0.546	10	253	56	7
IIS-CGT-GB		5.000 MWe	2.3	0.840	0.700	1.227	0.407	30	207	56	0
IIS-CGT-GC		5.000 MWe	2.3	0.840	0.700	1.227	0.407	200	207	56	0
IIS-CGT-GN		5.000 MWe	2.3	0.840	0.700	1.227	0.407	0	230	56	0
I.S-CGT-GN		5.000 MWe	2.3	0.840	0.660	1.867	0.827	0	230	56	0
I.L-CSG-GN	Gast. with a wasteheatboiler	30.000 MWe	1.7	0.850	0.700	1.219	0.764	0	230	56	0
IIS-CSG-GN	to produce highpr. steam for	30.000 MWe	1.7	0.850	0.700	1.233	0.653	0	230	56	0
I.S-CSG-GN	a backpressure turbine	30.000 MWe	1.7	0.850	0.660	1.888	1.133	0	230	56	0
OUT-CSG-GN		30.000 MWe	1.7	0.850	0.700	1.216	0.780	1463	230	56	0
OUT-CSG-GR		30.000 MWe	1.7	0.850	0.700	1.216	0.780	21	253	56	7
IFO-CTE-GN	Gasengine with wasteheat	2.500 MWe	2.1	0.860	0.639	1.921	1.644	0	1130	56	0
IFO-CTE-WW	boiler with possibility for	0.200 MWe	1.1	0.700	0.525	0	5.630	30	1400	56	0
IOI-CTE-WD	cofiring	0.125 MWe	1.0	0.530	0.525	1.800	5.000	30	200	56	100

INDUSTRIAL HEAT **COAL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ICH-SBO-CL		Boiler	50 MWt		0.87	0.69	0.441	-0.181	846	330	94	99
IFO-SBO-CL		Boiler	50 MWt		0.85	0.69	0.856	0.579	846	330	94	99
IFO-HET-CL		Heater	5 MWt		0.90	0.65	0.823	1.109	666	330	94	106
DORSEK												
CPKF10 N	LCV-1.0	FBC			0.80	0.30	0.429	4.00	141	75	94	14
CPKF15 N	LCV-1.5	FBC			0.80	0.30	0.429	4.04	193	75	94	15
CPMW07 N	HCV-0.7				0.80	0.30	0.338	2.44	482	94	94	16
CPMW10 N	HCV-1.0				0.80	0.30	0.338	2.42	807	94	94	17
CPWG10 N	LUMP-1.0				0.80	0.30	0.328	2.64	442	94	94	18
CPIKOK E	COKE				0.72	0.30		2.44	455	120	94	14
CPIMN1 E	LCV-1.0				0.67	0.30		2.88	904	160	94	629
CPIMW7 E	HCV-0.7				0.72	0.30		2.42	482	160	94	302
CPIMW1 E	HCV-1.0				0.72	0.30		2.20	807	160	94	319
CPIGR1 E	LUMP-1.0				0.72	0.30		2.44	443	160	94	183

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

INDUSTRIAL HEAT **GAS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ICH-SBO-GN			15 MWth		0.92	0.65	0.141	0.250	0	50	56	0
IFO-SBO-GN			15 MWth		0.90	0.65	0.226	0.420	0	50	56	0
ICH-HET-GN			5 MWth		0.90	0.65	0.136	0.260	0	113	56	0
IFO-HET-GN			5 MWth		0.90	0.65	0.195	0.370	0	113	56	0
IOM-HET-GN			5 MWth		0.90	0.65	0.221	0.420	0	113	56	0
DORSEK												
CPGZIE N	Natural Gas				0.87	0.30	0.078	0.44	0	35	55	0
CPIGZI E	Natural Gas				0.87	0.30		0.43	0	85	55	0

INDUSTRIAL HEAT OIL

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_1	Part.
SELPE												
ICH-SBO-OS			15 MWth		0.92	0.65	0.166	0.210	908	120	77	15
IFO-SBO-OS			15 MWth		0.90	0.65	0.267	0.400	908	120	77	15
IFO-HET-OM			5 MWth		0.90	0.65	0.200	0.300	116	83	73	6
IOI-HET-OM			5 MWth		0.90	0.65	0.270	0.500	116	83	73	6
IPA-HET-OS			5 MWth		0.90	0.65	0.265	0.400	908	175	77	15
IPE-HET-OS			5 MWth		0.90	0.65	0.165	0.210	908	175	77	15
DORSEK												
CPOLON N	HFO-1.2				0.83	0.30	0.129	0.91	592	90	77	15
CPOLOP N	HFO-2.5				0.83	0.30	0.129	0.89	1234	90	77	15
CPIOLN E	HFO-1.2				0.77	0.30		0.90	593	120	77	15
CPIOLO E	HFO-2.5				0.77	0.30		0.89	1235	120	77	15

INDUSTRIAL HEAT **OTHER PRIMARY and SECUNDARY FUEL**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
IFO-SBO-WA	Waste		50 MWth		0.85	0.69	0.900	1.650	30	200	0	100
IOI-SBO-WD	Wastewood		3 MWth		0.92	0.15	0.140	2.200	20	200	0	100
IFE-SBO-WH	Wasteheat		1 MWth		1.00	1.00	0.000	0.000	0	0	0	0
DORSEK												
CPPOZ1 N	Other prim.				0.79	0.30	0.388	2.97	226	118	101	16
CPPOZ2 N	Other sec.				0.79	0.30	0.388	2.97	226	118	101	16
CPIPO1 E	Other prim.				0.67	0.30		2.97	226	125	101	130
CPIPO2 E	Other sec.				0.67	0.30		2.97	226	125	101	130

INDUSTRIAL HEAT **FUTURE OPTIONS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
ICH-SHP-GN		Heatpump	8.3 MWth		1.00	0.46	0.315	1.088	0	580	45	0
IFO-SSO-RS		Sunheat	5 kWth		1.00	1.00	5.290	2.080	0	0	0	0
IIS-CFH-GN		Fuelcells	3 MWe		0.82	0.64	2.400	7.339	0	8	56	0
ICH-CFS-GN		Fuelcells	3 MWe		0.81	0.64	2.500	8.188	0	7	56	0
ICH-CGH-GN		Fuelcells	5 MWe		0.90	0.70	2.400	0.400	0	65	56	0

INDUSTRIAL HEAT **MISCELLANEOUS**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
IIS-SBO-GB			15 MWth		0.92	0.65	0.140	0.260	30	38	270	0
IIS-SBO-GC			15 MWth		0.92	0.65	0.137	0.260	200	75	47	0
IPE-SBO-GI			15 MWth		0.92	0.65	0.137	0.260	22	65	55	8
IPE-SBO-GR			15 MWth		0.92	0.65	0.132	0.260	10	120	56	7
IIS-HET-GB			5 MWth		0.90	0.65	0.140	0.260	30	38	270	0
IIS-HET-GC			5 MWth		0.90	0.65	0.135	0.260	200	132	47	0
IIS-HET-GH			5 MWth		0.90	0.65	0.140	0.260	0	100	0	0
IOI-HET-GH			5 MWth		0.90	0.65	0.226	0.410	0	100	0	0
IPE-HET-GI			5 MWth		0.90	0.65	0.136	0.260	22	106	55	8
IPE-HET-GR			5 MWth		0.90	0.65	0.136	0.260	10	215	56	7

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

Municipal **HEAT**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
coal												
SELPE												
HCV-BOI-CL			3 MWt		0.80	0.23	0.665	2.846	846	152	94	
DORSEK												
CKFM10 N					0.75	0.25	0.442	7.06	126	64	94	
CKMW07 N					0.75	0.25	0.346	4.88	452	94	94	
CKWGR7 N					0.75	0.25	0.346	4.88	386	94	94	
CKIGR1 E					0.68	0.25		4.66	608	160	94	
CKIMW1 E					0.65	0.25		4.62	757	160	94	
ENPEP												
42C E	HCV-0.7		16 MWt		0.69	0.28		11.6	493	54	92	270
coke												
DORSEK												
CKKOKS N					0.75	0.25	0.316	4.67	520	110	94	
CKIKOK E					0.65	0.25		4.66	378	104	89	

Municipal **HEAT**

Code	Fuel	Type	Unit	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/MWe	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
gas												
SELPE												
HCV-BOI-GN			3 MWt		0.85	0.11	0.100	0.400	0	50	56	
DORSEK												
CKGZIE N					0.85	0.25	0.073	0.74	0	35	55	
CKIGZI E					0.75	0.25		0.74	0	65	55	
ENPEP												
44C E			10 MWt		0.90	0.25		2.80	0	42	2	49
oil												
SELPE												
HCV-BOI-OM			2 MWt		0.85	0.11	0.100	0.400	116	50	73	
ENPEP												
43 E		IRB	46 MWt		0.89	0.29		3.1	1200	160	70	6
biomass												
DORSEK												
CKBIOM N					0.75	0.25	0.490	0.97	125	30	49	
other												
SELPE												
HPR-GHT-RG			0.15 PJ		1.00	0.25	152mFl/PJ	4.000				
HCV-HPM-GN			8.3 MWt		1.00	0.20	0.366	1.204	0	550	46	

OTHER PLANTS **COAL GASIFICATION (Lurgi etc.)**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
<u>SELPE</u>												
GTX-PLT-CL		Exxon SNG (Gasunie)	20 PJ		0.55	0.91	29.7	6.070	0	0	63	0
GCV-PLT-CL		Shell/Koppers (ind.)	20 PJ		0.77	0.91	23.7	2.850	0	0	51	0
GDX-PLT-CL		U-gas (VEGIN)	20 PJ		0.76	0.91	32.0	4.680	0	0	51	0
GUG-PLT-CL		underground	9.4 PJ		0.70	0.87	36.5	2.720	0	0	43	0
<u>DORSEK</u>												
ZWKKTO N		Coal Krupp-Koppers			0.56	1.00	60.4	2.60	29	0	0	13
ZWKLUR N		Coal Lurgi			0.44	1.00	56.2	2.93	25	0	0	25
ZWKTEX N		Coal Texaco			0.55	1.00	50.0	2.38	0	0	0	13
ZWBLUR N		Lignite Lurgi			0.45	1.00	61.3	1.93	25	0	0	25
KOGAPE N		Coalgasproduction			****	1.00	33.5	1.09	*	*	*	*

OTHER PLANTS **COAL GASIFICATION (misc.)**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
DORSEK												
towngas												
GAZOWN E					0.75	0.47			112	0	0	
gasgenerator												
CZADNI E					0.71	0.80			130	0	0	
low temperature carbonization												
WYTLEW E					0.78	0.71			120	0	0	

OTHER PLANTS **COKE PLANT**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJo	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
CCV-PLT-CO		Cokeoven	25 PJ		0.84	0.90	0.000	3.000	30	9	15	0
DORSEK												
KOKZNI E		Coke coal			0.77			0.25	32	11	3	52
KOKMOD E		Cokecoal mod.			0.77			1.31	4	4	3	520
ENPEP												
2 WKG		Cokeplants	13.7 PJ		0.85	0.98		0.37				

OTHER PLANTS **EXTRACTION**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
oil												
SELPE												
OPR-EXT-OF		Off-shore			1.00	1.00	0.0	0.000 (7.7)	0	0	0	0
OPR-EXT-OO		On-shore			0.90	1.00	0.0	0.000 (5.1)	0	140	6	0
DORSEK												
KOROPI E		Oilfields						1.47	0	0	0	0
ENPEP												
ROPKOP.ROP.NAF.(OIL-MINE)			4.2 PJ		1.00	0.77	0	0				
gas												
SELPE												
GPR-EXE-GG		Slochteren			0.995	1.00	0.0	0.630	0	1	0	0
GPR-EXG-GF		Off-shore			1.000	1.00	0.0	6.320-5.69	0	0	0	0
GPR-EXG-GG		Slochteren			0.992	1.00	0.0	0.630	0	2	0	0
GPR-EXG-GO		On-shore			0.984	1.00	0.0	2.530-1.90	0	4	1	0
GIM-TRL-GL		LNG	28 PJ		0.98	0.90	0.0	0.800	0	0	0	0
DORSEK												
KOGAZI E		Gasfields						1.04	0	0	0	
KOGAZM E		Gasfields, modernized						0.66	0	0	0	
KOGABU E		Gasfields under constr.						0.73	0	0	0	
ENPEP												
GZ		NG1-MINE	38 PJ/y		0.92	1.00		4.1				
GZ N		NG-OUTPUT2	23 PJ/y		1.00	1.00		3.2				
GZ N		NG-OUTPUT3	37.7 PJ/y		1.00	1.00		5.96				
GZ N		TR-LNG-IMP	7 PJ/y		1.00	1.00	3.5	0				
GZ		NG OUTPUT NITR.	76 PJ/y		1.00	0.98		5.7				

Comparison of conversion processes in different databases (DORSEK, ENPEP, SELPE)

OTHER PLANTS **MINES**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJo	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_1	Part.
mining												
DORSEK												
KWESPY N	Steamcoal K1					1.00	4.91	0.62	0	0	0	
KWECZ2 N	Steamcoal K2					1.00	5.46	0.71	0	0	0	
KWEWIS N	Steamcoal K3					1.00	4.73	0.60	0	0	0	
KWEZAT N	Steamcoal K4					1.00	5.28	0.64	0	0	0	
KOPEIS E	Steamcoal							0.80	0	0	0	
KOPEBU E	Steamcoal	Under construction						0.62	0	0	0	
KOPEIM E	Steamcoal	Modernized						0.49	0	0	0	
KOPKIS E	Cokingcoal							3.38	0	0	0	
KOPKBU E	Cokingcoal	Under construction						1.16	0	0	0	
KOPKIM E	Cokingcoal	Modernized						1.49	0	0	0	
KWBSZC N	Lignite					1.00	21.8	0.95	0	0	0	
KOPWBR E	Lignite							1.64	0	0	0	
ENPEP												
WK E	BITUM.COAL-MINE		all mines 3100 PJ/y		0.999	1.00		3.1				
WK E	COKECOAL-MINE		all mines 950 PJ/y		1.00			2.9				
WB E	LIGN-MINE1		per mine 35.3 PJ/y		1.00	0.98		1.8				
WB E	LIGN-MINE2		per mine 294.5 PJ/y		1.00	1.00		1.5				
WB E	LIGN-MINE3		per mine 39.5 PJ/y		1.00	0.98		1.65				
WB E	LIGN-MINE4		per mine 74.3 PJ/y		1.00	0.99		1.65				
WB E	LIGN-MINE5		per mine 138 PJ/y		1.00	1.00		1.4				
WB E	LIGN-MINE6		per mine 0.5 PJ/y		1.00	0.73		2.8				
WB E	LIGN-MINE7		per mine 0.5 PJ/y		1.00	1.00		2.8				

OTHER PLANTS **MINES (misc.)**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
briquetting												
DORSEK												
BRMWWK N	HCV fines				0.95	1.00	0.49	0.03	0	0	0	0
BRYKW1 E	Coal < 1.0				0.93			0.03	0	0	0	0
BRYKW7 E	Coal < 0.7				0.93			0.03	0	0	0	0
ENPEP												
16 WKE	BRYK.WEG.KAM		2.5 PJ		1.00	0.84	0.36	0.28				
28 WBR	BRYK.W.BRUN		2.4 PJ		0.98	1.00		0.03				
coal beneficiation												
DORSEK												
WZMIA1 N	LCV 0.7	-> HCV 0.7			0.74	1.00	0.50	0.03	0	0	0	0
WZMIA2 N	LCV 1.0	-> HCV 0.7			0.72	1.00	0.33	0.03	0	0	0	0
WZMIA5 N	LCV 1.5	-> HCV 1.0			0.81	1.00	0.46	0.03	0	0	0	0
ODSMN1 N	LCV 2.0	-> LCV 1.5			0.75	1.00	0.51	0.02	0	0	0	0

OTHER PLANTS **REFINERIES**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
refineries												
SELPE												
OCV-PLT-OC		Refinery			0.939	0.90	0.000	0.000	14	0	1	0
DORSEK												
RAFPAL N					0.88	1.00	5.82	0.21	0	0	0	0
RAFPET N					0.78	1.00	10.53	?	4	1	1	0
RAFIST E					0.70	1.00						
ENPEP												
1 ROP		Refinery	300 PJ/y		0.74	0.90	2.17	0.76				
gasification of oilresiduals												
DORSEK												
ZGPPRN N					0.73	1.00	96kZl/GJo/y	2.35	0	0	0	0

OTHER PLANTS **OTHER FUELS**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
DORSEK												
POZPA1 N	Other primary					0.00	0.00	0.00				
POZPA2 N	Other secomdary					1.00	0.31	1.024				
POINN1 E	Other primary							1.024	0	0	0	0
POINN2 E	Other secondary							1.024	0	0	0	0
ENPEP												
DTEPOZ.DRE.TOR.	(PEAT&WOOD)		0.03 PJ		1.00	1.00						
ODNPOZ.ODN.NOS.	(OTH.REN.EN.)		17.1 PJ		0.75	0.98						

OTHER PLANTS **SUBSTITUTION**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
<u>DORSEK</u>												
OLSUBN N	HFO 2.5	-> HFO 1.2			0.98	1.00	5.74	2.39				
SGZISK N	Natural Gas	-> BTU Gas			1.00	1.00	0.00	0.51				
SGSKZI N	BTU Gas	-> Natural Gas			1.00	1.00	0.00	0.00				
SKPOKM N	Industrial Coke	-> Metall. Coke			1.00	1.00	0.00	0.34				
SGZISY N	Natural Gas	-> Synthesis Gas			1.00	1.00	0.00	0.34				
SWGMW1 N	Lump coal	-> HCV fines 0.7			0.99	1.00	0.00	0.00				
SWGMW2 N	Lump coal	-> HCV fines 1.0			0.99	1.00	0.00	0.00				
SWMNW1 N	LCV fines	-> HCV fines 0.7			1.00	1.00	0.00	0.034				
SWMNW2 N	LCV fines	-> HCV fines 1.0			1.00	1.00	0.00	0.034				
SWMWK1 N	HCV fines 0.7	-> Coking coal			1.00	1.00	0.00	0.034				
SWMWK2 N	HCV fines 1.0	-> Coking coal			1.00	1.00	0.00	0.034				

OTHER PLANTS **FUTURE OPTIONS**

Code	Fuel	Type	Unit output	H/P	Eff.	Use	Spec.inv. 10^6 Dfl/PJ_o	O&M Dfl/GJ_o	SO_2	NO_x (k)	CO_2 tons/PJ_i	Part.
SELPE												
GHP-ELL-EL		Prod. of Hydrogen	250 MWt		0.85	0.97	1.000	2.000	0	0	0	0
GMP-PLT-CL		Methanol from coal	40 PJ		0.63	0.85	2.000	6.700	0	0	50	0
GMP-PLT-GN		Methanol from gas	40 PJ		0.75	0.85	0.670	2.130	0	0	4	0
GTX-GCT-GT		Transport of gas			0.998	1.00	0.000	0.000	0	1	0	0

APPENDIX B: ABATEMENT TECHNOLOGIES

CONTENTS

PAGE

1. General remarks

In SELPE there are many abatement options for the different processes. The code explains the main function but there are slight differences. So a short explanation.

SO_2 reduction by:

GIPS	Flue Gas Desulphurization 85%
KALK-INJ	Limestone injection in furnaces
AFBC-S	Adding limestone to FBC
FUELS-MID	Substitution residual oil by gas in refineries
LS-1-OH	Heavy fuel oil from 1.8 % S to 1.0% S
LS-2-OM	Gasoil from 0.25% S to 0.20% S
LS-05-OM	Gasoil etc. from 0.2% S to 0.05% S
CLAUS	Tailgasunit Claus from 95% to 99% desulpurization
HFCL-EF-W	Effect cleaning fluegas (HCl and HF) for incinerators
RG-OPT-	Optimization desulphurisation in powerstations
TFC-CC-G	Lower S in FCC-gas by using transferkatalyser at the refineries

NO_x reduction by:

LNB-TTV_	Low NO_x burner and Two Stage Combustion
LBZB	Low Burner Load
AFBC	Effect use of FB
DRY-TEC-	Low NO_x burner in Gasturbine
H2O-INJ-	Injection of water into Gasturbine
RGR-NN-	Fluegas recirculation and low NO_x burners
RLB-NB-	Retrofit low NO_x burners (old and new processes)
EB-OTH-W	Abatement in combustion for other solid fuels
VTB-RGR	Low NO_x burners for small boilers
SCRI-	Fluegas denetrification by SCR for coal and other solids (no power plants)
SCR-	SCR in powerplants
LUVO-KT-	Partly fluegas denitrification by LUVU-SCR in powerplants

Particulates reduction by:

ELEC-ST	Electrostatic filter
FILTER-	Bagfilter
FILTEX-	Higher efficiency of filters

SO_2 abatement **Public Power Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^5 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
DORSEK							
NEW							
SPEWS1	SD	HCV 1.0	ELMW10	0.740	0.233	0.615	-611
SPENS1	SD	LCV 1.0	ELMN10	0.740	0.233	0.640	-681
SPENM5	WET	LCV 1.5	ELMN15	0.740	0.278	0.870	-1030
SPENM2	WET	LCV 2.0	ELMN20	0.740	0.278	0.963	-2204
SPEBM6	WET	LIGN 0.6	ELWB06	0.740	0.262	0.808	-979
SPEBS6	DRY	LIGN 0.6	ELWB06	0.740	0.053	0.186	-361
SPEBM2	WET	LIGN 1.2	ELWB12	0.740	0.262	0.900	-2156
SPEOLN	WET	HFO 1.2	ELOLON	0.740	0.278	0.826	-463
SPEOLO	WET	HFO 2.5	ELOLOP	0.740	0.278	0.863	-964
EXIST							
SIEWS1	SD	HCV 1.0	ELZW10	0.630	0.271	0.833	-583
SLIW10	LIFAC	HCV 1.0	ELZW10	0.630	0.169	0.419	-481
SIENS1	SD	LCV 1.0	ELZN10	0.630	0.271	0.856	-641
SIENM5	WET	LCV 1.5	ELZN15	0.630	0.325	0.892	-978
SIENM2	WET	LCV 2.0	ELZN20	0.630	0.325	0.978	-2118
SIEBM6	WET	LIGN 0.6	ELZB06	0.630	0.305	0.988	-957
SIEBS6	DRY	LIGN 0.6	ELZB06	0.630	0.049	0.187	-353
SIEBD2	WET	LIGN 1.2	ELZB12	0.630	0	0.102	-1139
SIEOLN	WET	HFO 1.2	ELZOLN	0.630	0.325	0.826	-453
SIEOLO	WET	HFO 2.5	ELZOLO	0.630	0.325	0.863	-945

SO_2 abatement **Public Power Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
SELPE							
GIPS-C1	FGD 85%	CL 0.8	ECV-C01-CL		0.185	1.900	-816
GIPS-C2	FGD 85%	CL 0.8	ECV-C01-CL		0.250	2.063	-816
GIPS-C3	FGD 85%		ECV-C01-FU		0.000	0.312	-326
GIPS-O1	FGD 85%	HFO	ECV-C01-OH		0.185	1.721	-652
GIPS-O2	FGD 85%		ECV-OGA-OS		0.250	2.063	-651
RG-OPT-C1	FGD optim.		ECV-C01-CL		0.000	0.084	-56
RG-OPT-C3	FGD optim.		ECV-C01-FU		0.000	0.014	-22
RG-OPT-O1	FGD optim.		ECV-C01-OH		0.000	0.069	-39
RG-OPT-O2	FGD optim.		ECV-OGA-OS		0.000	0.069	-39
ENPEP							
Forced Oxidation Wet Limestone Scrubber					0.310	2.167	90%
Limestone gypsum					0.341	1.998	90%
N 26,31 Prot. 360/500 MWe Wet scrubber					0.34-->0.27	0.24-->0.16	90%
N 60 LCV 1.0 500 MWe Retrofit wet scrubber					0.44-->0.35	0.24-->0.16	90%

SO_2 abatement **Public Combined Heat and Power**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
DORSEK							
NEW							
SPECW7	SD	HCV 0.7	ECMW07	0.550	0.350	0.359	-404
SPECW1	SD	HCV 1.0	ECMW10	0.550	****	0.528	-672
SPECN7	SD	LCV 0.7	ECMN07	0.550	0.363	0.376	-514
SPECM1	WET	LCV 1.0	ECMN10	0.550	0.414	0.408	-841
SPECS1	SD	LCV 1.0	ECMN10	0.550	****	0.522	-619
SPECZN	WET	HFO 1.2	ECZOLN	0.550	****	0.534	-546
SPECZO	WET	HFO 2.5	ECZOLO	0.550	0.377	0.403	-1138
EXIST							
SIECW7	SD	HCV 0.7	ELCZW7	0.550	1.454	0.532	-427
SIECW1	SD	HCV 1.0	ELCZW1	0.550	1.454	0.560	-692
SIECN7	SD	LCV 0.7	ELCZN7	0.550	1.530	0.546	-532
SIECS1	SD	LCV 1.0	ELCZN1	0.550	1.530	0.557	-631
SIECM5	WET	LCV 1.5	ELCZN5	0.550	1.749	0.635	-1160
SIECZN	WET	HFO 1.2	ELCZON	0.550	1.595	0.606	-543
SIECZO	WET	HFO 2.5	ELCZOL	0.550	1.595	0.628	-1132
SELPE							
AFBC-S-C5	Fluidized bed		EHP-CBP-CL		0.166	0.880	-593
HFCL-EF-W1	Effect of HCl/HF red.		EHP-INC-WI		0.000	0.000	-56
LS-1-OH1	HFO 1.8 --> 1.0 S		EHP-CBP-OS		0.000	0.000	-414

SO_2 abatement **Industrial Power and Heat Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_1
DORSEK							
NEW							
SECPW7	SD	HCV 0.7	ECPW07	0.370	0.407	0.350	-338
SECPN1	SD	LCV 1.0	ECPN10	0.370	0.481	0.418	-720
SECPW1	SD	HCV 1.0	ECPW10	0.370	0.432	0.350	-603
SECPON	WET	HFO 1.2	ECPOLN	0.370	0.484	0.431	-248
SECPOL	WET	HFO 2.5	ECPOLO	0.370	0.484	0.441	-517
EXIST							
SIEPW7	SD	HCV 0.7	ELCPW7	0.320	0.759	0.372	-329
SIEPW1	SD	HCV 1.0	ELCPW1	0.320	0.759	0.389	-521
SIEPN1	SD	LCV 1.0	ELCPN1	0.320	0.807	0.397	-576
SIEPON	WET	HFO 1.2	ELCPON	0.320	1.228	0.505	-496
SIEPOL	WET	HFO 2.5	ELCPOL	0.320	1.228	0.522	-1034
SELPE							
AFBC-S-C1	Limestone for FBC		ICH-CBP-CL		0.2040	0.8890	-593

SO_2 abatement **Industrial Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
DORSEK							
NEW							
SNCPW7	LIFAC	HCV 0.7	CPMW07	0.300	0.063	0.397	-337
SNCPW1	LIFAC	HCV 1.0	CPMW10	0.300	0.068	0.417	-605
SNCPG1	LIFAC	LUMP 1.0	CPWG10	0.300	0.063	0.397	-310
SNCPON	WET	HFO 1.2	CPOLON	0.300	0.096	0.484	-533
SNCPOL	WET	HFO 2.5	CPOLOP	0.300	0.096	0.497	-1111
EXIST							
SCPIW7	DRY	HCV 0.7	CPIMW7	0.300	0.025	0.155	-193
SCPIW1	DRY	HCV 1.0	CPIMW1	0.300	0.025	0.174	-323
SCPIG1	DRY	LUMP 1.0	CPIGR1	0.300	0.025	0.155	-177
SCPION	WET	HFO 1.2	CPIOLN	0.300	0.096	0.484	-533
SCPIOL	WET	HFO 2.5	CPIOLO	0.300	0.096	0.503	-1111
SELPE							
AFBC-S-C2	Limestone for FBC		ICH-SBO-CL		0.033	0.914	-593
AFBC-S-C3	Limestone for FBC		IFE-SBO-CL		0.042	0.903	-593
KALK-INJ-2	Limestone inj. heaters		IFO-HET-CL		0.060	0.417	-413

SO_2 abatement **Municipal Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
DORSEK							
NEW							
SCKMW7	DRY	HCV 0.7	CKMW07	0.250	0.031	0.180	-249
SCKG07	DRY	LUMP 0.7	CKWGR7	0.250	0.031	0.174	-193
EXIST							
SICKM1	DRY	HCV 0.7	CKIMW1	0.250	0.031	0.186	-303
SICK10	DRY	LUMP 1.0	CKIGR1	0.250	0.031	0.186	-243

SO_2 abatement **Miscellaneous**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	SO_2 t/PJ_i
DORSEK							
SOLN15	HDES	DIES 0.15			0.000	0.062	-512
SOLN30	HDES	DIES 0.30			0.000	0.021	0
SELPE							
CLAUS-00BG	Tailgasunit in refineries		OCV-PLT-OC		0.032	0.006	-11
CLAUS-15BG	95 -> 99% desulferization		OCV-PLT-OC		0.061	0.011	-21
FUELS-MID1	Substitution of residual		OUT-CGF-GN		0.000	0.000	-1463
FUELS-MID2	oil by gas in refineries		OUT-CBP-GN		0.000	0.000	-1463
FUELS-MID4			OUT-CFH-GN		0.000	0.000	-1463
TFC-CC-G1	Low S in FCC-gas		OUT-HEF-GP		0.000	0.000	-2100

NO_x abatement **Public Power Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
DORSEK							
NEW							
NPEKSC	SCR	COAL N PPP	ELMW10	0.740	0.126	0.820	-140
NPEBSC	SCR	LIGN N PPP	ELWB12	0.740	0.118	0.808	-117
NPEOSC	SCR	HFO N PPP	ELOLON	0.740	0.126	0.795	-93
EXIST							
NIEKSC	SCR	COAL E PPP	ELZN10	0.630	0.187	0.862	-116
NIEKPI	PM	COAL E PPP	ELZW10	0.630	0.023	0.000	-10
NIEBPI	PM	LIGN E PPP	ELZB12	0.630	0.023	0.000	-53
NIEBSC	SCR	LIGN E PPP	ELZB12	0.630	0.176	0.790	-112
SELPE							
LNB-C4	Low NO_x burner		ECV-CO1-CL		0.009	0.000	-100
RLB-NB-C4	Retrofit LNB		ECV-CO1-CL		0.060	0.200	-55
LUVO-KT-C1	LUVO - SCR		ECV-CO1-CL		0.069	1.083	-120
SCR-C1	SCR		ECV-CO1-CL		0.151	1.989	-240
LNB-TTV-C1	LNB + Two Stage Comb.		ECV-CO2-CL		0.013	0.000	-135
LUVO-KT-C2	LUVO-SCR		ECV-CO2-CL		0.043	0.079	-36
RLB-NB-C5	Retrofit LNB		ECV-CO2-CL		0.050	0.200	-37
SCR-C5	SCR		ECV-CO2-CL		0.102	0.971	-116
DRY-TEM-8	Low NO_x combustion		ECV-COG-CL		0.056	0.000	-150
DRY-TEM-9	room for GT		ECV-COV-CL		0.066	0.000	-150
RGR-NN-G34	FG recirculation		ECV-OGA-GB		0.050	0.180	-50
RLB-OB-G32	Retrofit LNB		ECV-OGA-GN		0.023	0.000	-45
RLB-OB-O13	Retrofit LNB		ECV-OGA-OS		0.060	0.563	-64

NO_x abatement **Public Power Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
SELPE							
H2O-INO-9	Injection of water		ECV-SCO-GN		0.006	0.476	-50.0
H2O-INJ-7	in GT		ECV-STG-GN		0.017	0.519	-95.0
H2O-INE-7	(extra)		ECV-STG-GN		0.000	0.850	-70.0
DRY-TEO-9	Dry technics		ECV-SCO-GN		0.020	0.000	-50.0
DRY-TEC-7	for lower NO_x		ECV-STG-GN		0.050	0.000	-95.0
DRY-TEC-10	in GT		ECV-STN-GN		0.052	0.000	-95.0
DRY-TEE-7			ECV-STG-GN		0.006	0.000	-80.0
DRY-TEE-10			ECV-STN-GN		0.007	0.000	-90.0
DRY-TEM-3			ECV-STV-GN		0.061	0.000	-160.0
ENPEP							
	Low NO_x burner				0.046		50%
	SCR				0.144	2.545	80%

NO_x abatement **Public Combined Heat and Power**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
DORSEK							
NEW							
NPECSC	SCR	COAL N CHP	ECMW10	0.550	0.160	0.446	-137
NPECOS	SCR	HFO N CHP	ECZOLN	0.550	0.151	0.430	-93
EXIST							
NIECSC	SCR	COAL E CHP	ELCZN1	0.550	1.181	0.557	-137
NIECZP	PM	COAL E CHP	ELCZW1		0.104	0.009	-121
SELPE							
AFBC-C1	Effect FB		EHP-CBP-CL		0.000	0.000	-180
SCRI-BC7	SCR		EHP-CBP-CL		0.406	0.579	-114
LNB-TTV-G8			EHP-CBP-GN		0.048	0.000	-44
RLB-NB-G1			EHP-CBP-GN		0.110	0.000	-14
RGR-NN-G1			EHP-CBP-GN		0.110	0.100	-39
RLB-OB-G1			EHP-CBP-GN		0.150	0.000	-58
LBZB-O1			EHP-CBP-OS		0.025	0.000	-29
LNB-TTV-O3			EHP-CBP-OS		0.048	0.150	-73
RGR-NN-O1			EHP-CBP-OS		0.110	0.100	-55
RLB-OB-O1			EHP-CBP-OS		0.150	0.150	-15
H2O-INJ-6			EHP-CSG-GN		0.020	0.293	-95
DRY-TEC-6			EHP-CSG-GN		0.059	0.000	-95
H2O-INE-6			EHP-CSG-GN		0.000	0.480	-70
DRY-TEE-6			EHP-CSG-GN		0.007	0.000	-80
M-SCR-O3			EHP-CTE-OM		0.254	0.900	-700
SCRI-MW3			EHP-INC-WI		0.205	1.200	-108
SCRI-MW2			EHP-INC-WI		0.242	1.620	-108
DRY-TEC-15			EPH-CSG-GN		0.059	0.000	-95
DRY-TEE-15			EPH-CSG-GN		0.007	0.000	-90
DRY-TEM-1			ECV-OIG-OH		0.056	0.000	-160
DRY-TEM-2			ECV-OIV-OH		0.063	0.000	-160

NO_x abatement **Industrial Power and Heat Plants**

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Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
DORSEK							
NEW							
EXIST							
NIECPP	PM	COAL E IPP	ECCPW1		0.104	0.009	-48
SELPE							
AFBC-C1			ICH-CBP-CL		0.000	0.000	-180
SCRI-BC1			ICH-CBP-CL		0.493	0.511	-114
LBZB-01			ICH-CBP-OS		0.025	0.000	-29
LNB-TTV-03			ICH-CBP-OS		0.048	0.150	-73
RGR-NN-01			IFO-CBP-OS		0.110	0.100	-55
RGR-NN-05			ICH-CBP-OS		0.130	0.100	-55
RLB-OB-01			IFO-CBP-OS		0.150	0.150	-15
RLB-OB-05			ICH-CBP-OS		0.170	0.150	-15
LNB-TTV-G8			ICH-CBP-GN		0.048	0.000	-44
RGR-NN-G1			IFO-CBP-GN			0.110	0.100-39
RGR-NN-G5			ICH-CBP-GN		0.140	0.100	-39
RLB-NB-G1			IFO-CBP-GN		0.110	0.000	-14
RLB-NB-G5			ICH-CBP-GN		0.140	0.000	-14
RLB-OB-G1			IFO-CBP-GN		0.150	0.000	-58
RLB-OB-G5			ICH-CBP-GN		0.190	0.000	-58

NO_x abatement **Industrial Power and Heat Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
SELPE							
LBZB-G7			IPE-CBP-GR		0.025	0.000	-64
LNB-TTV-G7			IPE-CBP-GR		0.049	0.000	-105
RGR-NN-G11			IPE-CBP-GR		0.140	0.100	-38
RLB-OB-G11			IPE-CBP-GR		0.190	0.000	-52
RLB-NB-G11			IPE-CBP-GR		0.140	0.000	-13
LBZB-G8			IIS-CBP-GC		0.025	0.000	-29
LNB-TTV-G9			IIS-CBP-GC		0.049	0.000	-55
RGR-NN-G16			IIS-CBP-GC		0.130	0.100	-35
RLB-NB-G16			IIS-CBP-GC		0.130	0.000	-10
RLB-OB-G16			IIS-CBP-GC		0.170	0.000	-36
LNB-G9			IPE-CBP-GI		0.032	0.000	-25
RGR-NN-G12			IPE-CBP-GI		0.140	0.100	-38
RLB-NB-G12			IPE-CBP-GI		0.140	0.000	-13
RLB-OB-G12			IPE-CBP-GI		0.190	0.000	-38
RGR-NN-G17			IIS-CBP-GB		0.170	0.100	-21
LNBTTV-G11			IPE-CCO-GN		0.021	0.000	-44
RGR-NN-G8			IPE-CCO-GN		0.029	0.290	-39
RLB-NB-G8			IPE-CCO-GN		0.029	0.000	-14
RLB-OB-G8			IPE-CCO-GN		0.046	0.000	-58
LNB-G10			IPE-CCO-GI		0.014	0.000	-25
RGR-NN-G10			IPE-CCO-GI		0.029	0.290	-38
RLB-NB-G10			IPE-CCO-GI		0.029	0.000	-13
RLB-OB-G10			IPE-CCO-GI		0.046	0.000	-38
LBZB-G9			IPE-CCO-GR		0.009	0.000	-64
LNBTTV-G10			IPE-CCO-GR		0.021	0.000	-105
RGR-NN-G9			IPE-CCO-GR		0.029	0.290	-38
RLB-NB-G9			IPE-CCO-GR		0.029	0.000	-13
RLB-OB-G9			IPE-CCO-GR		0.170	0.000	-54

NO_x abatement **Industrial Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ$_o$	NO_x t/PJ$_i$
DORSEK							
NEW							
EXIST							
NCPIPI	PM	COAL E IHP	CPIMW1	0.300	0.011	0.000	-64
SELPE							
SCRI-BC2			ICH-SBO-CL		0.090	0.560	-114
LNB-09			ICH-SBO-OS		0.007	0.150	-33
RGR-NN-02			IFO-SBO-OS		0.011	0.100	-55
RGR-NN-06			ICH-SBO-OS		0.014	0.100	-55
VTB-RGR-03			IOM-SBO-OG		0.012	0.100	-23
RGR-NN-G3			IFO-SBO-GN		0.018	0.100	-33
RGR-NN-G6			ICH-SBO-GN		0.020	0.100	-33
RLB-OB-G3			IFO-SBO-GN		0.018	0.000	-8
RLB-OB-G6			ICH-SBO-GN		0.020	0.000	-8
SCRI-KW1			IOI-SBO-WD		0.169	2.662	-164
SCRI-KW4			IFO-SBO-WA		0.169	0.967	-164

NO_x abatement **Industrial Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
SELPE							
LBZB-G4			IPE-SBO-GI		0.005	0.000	-10
RGR-NN-G14			IPE-SBO-GI		0.020	0.100	-38
RLB-NB-G14			IPE-SBO-GI		0.020	0.000	-13
RLB-OB-G14			IPE-SBO-GI		0.020	0.000	-23
RLB-OB-G18			IIS-SBO-GC		0.020	0.000	-33
RLB-NB-G18			IIS-SBO-GC		0.020	0.000	-10
LBZB-G5			IIS-SBO-GC		0.005	0.000	-23
RGR-NN-G18			IIS-SBO-GC		0.020	0.100	-35
LBZB-G6			IPE-SBO-GR		0.005	0.000	-24
LNB-TTV-G6			IPE-SBO-GR		0.010	0.000	-65
RGR-NN-G13			IPE-SBO-GR		0.014	0.100	-38
RLB-NB-G13			IPE-SBO-GR		0.014	0.000	-13
RLB-OB-G13			IPE-SBO-GR		0.020	0.000	-54
RGR-NN-G21			IIS-SBO-GB		0.020	0.100	-21

NO_x abatement **Municipal Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	NO_x t/PJ_i
DORSEK							
NEW							
EXIST							
NICKPI	PM	COAL E MHP	CKIMW1	0.250	0.010	0.000	-61
SELPE							
AFBC-C3			HCV-BOI-CL		0.000	0.000	-70
RLB-OB-G30			HCV-BOI-GN		0.019	0.000	-8
RGR-NN-G30			HCV-BOI-GN		0.019	0.100	-33
RGR-NN-O11			HCV-BOI-OM		0.019	0.100	-18
M-RGRG11			HCV-HPM-GN		0.003	0.000	-186
M-LEANBG11			HCV-HPM-GN		0.004	0.000	-413
M-LEANSG11			HCV-HPM-GN		0.003	0.006	-34
M-LEANEG11			HCV-HPM-GN		0.008	0.016	-56
VTB-RGRG11			HCV-HPM-GN		0.013	0.000	-15

Particulate abatement **Public Power Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	Part. t/PJ_i
DORSEK							
NEW							
EXIST							
OIEMW1	PR	HCV 1.0	ELZW10	0.630	0.033	0.054	0
OIEMN1	PR	LCV 1.0	ELZN10	0.630	0.033	0.054	0
OIEMN5	PR	LCV 1.5	ELZN15	0.630	0.033	0.054	0
OIEMN2	PR	LCV 2.0	ELZN20	0.630	0.033	0.054	0
OIEBS6	PR	LIGN 0.6	ELZBO2		0.332	0.011	-392
SELPE							
ELEC-STOF2			ECV-CO1-CL		0.033	0.147	-95
ELEC-STOF2			ECV-CO2-CL		0.033	0.147	-95
ELEC-STOF3			ECV-CO1-FU		0.000	0.024	-38
ELEC-STOF3			ECV-CO2-FU		0.000	0.024	-38
ELEC-ST-O1			ECV-CO1-OH		0.033	0.147	-16
ENPEP							
	Precipitator				0.088	0.365	99.5%
	Baghouse				0.098	0.405	99.9%
	Cyclone				0.055	0	85.0%

Particulate abatement **Public Combined Heat and Power**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	Part. t/PJ_i
DORSEK							
NEW							
EXIST							
OIECW7	PR	HCV 0.7	ELCZW7	0.550	0.142	0.049	-1
FILTER-9			EHP-CBP-CL		0.065	0.122	-81
FILTEX-9			EHP-CBP-CL		0.013	0.020	-12
DIOX-EF-W1			EHP-INC-WI		0.000	0.000	-32

Particulate abatement **Industrial Power and Heat Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	Part. t/PJ_i
DORSEK							
NEW							
EXIST							
OECPW7	PR	HCV 0.7	ELCPW7	0.320	0.000		-522
OECPW1	PR	HCV 1.0	ELCPW1	0.320	0.000		-546
OECPN1	PR	LCV 1.0	ELCPN1	0.320	0.444	0.178	-1079
OECPN5	PR	LCV 1.5	ELCPN5	0.320	0.000		-1125
OECPPO	PR	OTH SEC	ELCPO2	0.320	0.000		-116
SELPE							
FILTER-8			ICH-CBP-CL		0.0810	0.1200	-81
FILTER-3			OUT-CBP-CL		0.0630	0.1460	-82
FILTEX-8			ICH-CBP-CL		0.0160	0.0200	-12
FILTEX-3			OUT-CBP-CL		0.0126	0.0200	-12
FILTER-W3			IOI-CTE-WD		0.0460	0.2670	-93
FILTER-W4			IOI-CTE-WD		0.0920	0.2670	-82

Particulate abatement **Industrial Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	Part. t/PJ_i
DORSEK							
NEW							
EXIST							
OPIMW7	PR	HCV 0.7	CPIMW7	0.300	0.018	0.099	-297
OPIMW1	PR	HCV 1.0	CPIMW1	0.300	0.018	0.099	-297
OPIMN1	PR	LCV 1.0	CPIMN1	0.300	0.018	0.106	-622
OPIGR1	PR	LUMP 1.0	CPIGR1	0.300	0.035	0.193	-173
OPIPPO	PR	OTH SEC	CPIPO2	0.300	0.018	0.106	-173
SELPE							
FILTER-4			ICH-SBO-CL		0.011	0.157	-81
FILTEX-4			ICH-SBO-CL		0.002	0.020	-12
FILTER-7			IPE-SBO-CL		0.014	0.167	-81
FILTEX-7			IPE-SBO-CL		0.003	0.020	-12
FILTER-W5			IOI-SBO-WD		0.013	0.154	-93
FILTER-W6			IOI-SBO-WD		0.027	0.154	-82
FILTER-W8			IFO-SBO-WA		0.017	0.187	-93
FILTER-6			IFO-HET-CL		0.012	0.134	-81
FILTEX-6			IFO-HET-CL		0.002	0.020	-12
DIE-EFF-O2			IFO-MEQ-OM		0.000	0.000	-90

Particulate abatement **Municipal Heating Plants**

Abatement	Type	Fuel	Process	Avail.	Spec.inv. 10^6 Dfl/Mw	Var.cost Dfl/GJ_o	Part. t/PJ_i
DORSEK							
NEW							
EXIST							
OKIM10	PR	HCV 1.0	CKIMW1	0.250	0.029	0.193	0
OKIGR1	PR	LUMP 1.0	CKIGR1	0.250	0.029	0.193	0
SELPE							
FILTER-6			HCV-BOI-CL		0.012	0.134	-82
FILTEX-6			HCV-BOI-CL		0.002	0.020	-11

APPENDIX C: DATA FROM REFINERY MODEL SERUM

A model on the refining industry in the Netherlands

1. General

On request of the Ministry of Economic Affairs, the unit ECN - Policy Studies of Netherlands Research Foundation (ECN) has developed a model on the refining industry in the Netherlands. The LP-model, called SERUM (Static ESC Refinery Utility Model), is able to calculate the effects of various changes in the refinery environment, e.g. changes in crude slate, feedstock, product demand, product specifications, energy use and emission standards. The model will be used for long term analysis on the base of energy scenarios developed by ECN - Policy Studies. This report outlines assumptions, methodology, specifications and possible applications of the model.

The model describes the conversion of three crudes (Brent Blend, Iranian Light and Arabian Heavy) and different feedstock into oil products. In three modules, the model distinguishes three separate refinery functions, viz. refining, blending, and heat and power generation (utility function). The refining module specifies the processing of crudes and feedstock in different processing units, e.g. atmospheric distillation, vacuum distillation, catalytic cracking as well as hydrocracking, hydrotreating and other refinery processes. Process specifications include data on costs, product yields, energy requirements, type of fuel used, emissions, and blending data. Equations in the blending module represent the blending of intermediate product streams into oil products, conform the product specifications identified in the model. Finally, the utility module specifies different type of furnaces, boilers, gasturbines and the fuels used to generate the energy (steam, heat, electricity) required for refining. This module includes data on generation costs, energy conversion efficiencies, SO_2 and NO_x emissions.

The refining industry is in the model represented by three different configurations. Each configuration stands for a type of refinery with specific processes. A so called "traditional" configuration presents a refinery with distillation, visbreaker, catcracker and hydrocracker as separate processes. A "coking" refinery is supplemented with flexicoking and hydrocracker processes. The third "hycon" configuration contains hydroconversion and catcracking instead of flexicoking and hydrocracker processes. Distinguishing in the model three different refineries with specific processes allows for smaller exchanges of intermediate products than otherwise will occur. Of course it also provides additional information about the configurations developments.

Changes in product specifications, demand mix, prices of crudes and feedstock as well as the use of other types of energy (electricity, natural gas, etc.) can be evaluated by the model.

The data about investment and O & M cost were collected in 1984, so a total inflation correction of about 6.5 % have to be used to get Dutch florins of 1990. The model is used now for studying the Dutch situation but we think it possible to use it in any country. The model can be changed as necessary. ECN - Policy Studies has the intention to update the model in the near future.

2. Data

Within the model the main part is the so called *PRODUCER* that contains as a hierarchy *PLANTs*, *UNITs* and *PROCESSes*. A masterlist of *PRODUCERs* is given on page 101. Data concerning the PROCESSes have been shown on pages 102-105, viz.:

- General processdata,
- Requirements,
- Intermediate products,
- Final products,
- Emissions,
- Crude oil tags.

Per item a short explanation has been given. Page 106 contains data on blending qualities, octane rate and lead tags of benzine. Data concerning *UNITs* are given viz.:

- Lower and upper bounds of capacity (10^6 tons/year),
- Specific investment (Dfl/ton);
- Fixed cost (Dfl/ton),
- Annuity depending on discount rate and lifetime.

The *PROCESSes* have been related to the crude oil tag, so sometimes the data of the processes for one PRODUCER are nearly all the same.

3. Contents

LIST OF THE ENERGY PRODUCER

ALKYLATION	ALKYLATION
AM-SULFREC	AMINO TREATMENT AND SULPHUR RECOVERY
BLEND-CONV	CONVERSION OF FINAL PRODUCTS FROM TON TO PJ /
BLENDING	BLENDING PROCESS
C-REFORMER	CATALYTIC REFORMER
C4-ISO	C4 ISOMERATION
C56-ISO	C56 ISOMERATION
CRACKERS	CRACKING (HYDRO-CRACKERS AND CATALYTIC CRACKERS)
CRUDE-DIST	ATMOSPHERIC DISTILLATION OF CRUDE OIL
GAS-PLANT	GAS-PLANT (SEPARATES THE VARIOUS PROPANE AND BUTANE STREAMS)
H2FINER	PRE-HYDROTREATER FOR COKER PRODUCTS
H2TREATING	HYDROTREATER
HYDROGEN-P	HYDROGEN PRODUCER
RESID-UPGR	RESIDUE UPGRADING
UTILCLEAN	SO2 REDUCTION OPTIONS FOR UTILITIES
UTILITIES	ENERGY UTILITIES
VAC-DIST	VACUUM DISTILLATION OF ATMOSPHERIC RESIDUE

LIST OF PROCESLABELS IN TABLES

* **General Data**

ABATM-COST	ABATMENT COSTS OF THE PROCESSES OF UTILITIES
EFFICIENCY	EFFICIENCY COSTS OF THE PROCESSES OF UTILITIES
UFAC	UTILISATION FACTOR OF THE PROCESS
VAR-COSTS	VARIABLE PROCESCOSTS OF THE PROCESS

* **Requirements**

COOLING-W	COOLING WATER
HEAT	HEAT
POWER	POWER
STEAM	STEAM

* **Intermediate products**

ALKYL-TAR	ALKYLATION TAR
ALKYLATE	ALKYLATE
ASPHALT-R	ASPHALTIC RESIDUE
ATM-RESID	ATMOSPHERIC RESIDUE
ATM-R-FEED	ATMOSPHERIC RESIDUE USED AS FEEDSTOCK
ATM-RES-D	DE-SULPHURISED ATMOSPHERIC RESIDUE
C1C2	REFINERY GASES
C3	PROPANE
C3-GP	PROPANE-STREAM FROM GAS-PLANT
CK-NAPHTA	COKER-NAPHTHTA
CK-GASOLIN	COKER GASOLINE
COAL	COAL
CONDENSATE	NATURAL GAS CONDENSATE
CR-NAPHTA3	CRACKED NAPHTHA SEVERITY 3
CR-NAPHTA1	CRACKED NAPHTHA SEVERITY 1
CR-NAPHTA2	CRACKED NAPHTHA SEVERITY 2
CRUDE	CRUDE
D-KEROSENE	DESULPHURISED KEROSENE
DA-OIL	DEASPHALTED OIL
DCK-GASOIL	DESULPHURISED COKER GASOIL
DEL-GASOIL	DELAYED COKER GASOIL
DFC-GAS	LOW SULPHUR FLUID CATALYTIC CRACKING GAS (ALL CRUDES)
DL-CY-OIL	DESULPHURISED LIGHT CYCLE OIL
DLV-GASOIL	DELAYED COKER VACUUM GASOIL
DSH-GASOIL	DESULPHURISED HEAVY STRAIGHT RUN GASOIL
DSL-GASOIL	DESULPHURISED LIGHT STRAIGHT RUN GASOIL

LIST OF PROCESLABELS IN TABLES

* **Intermediate products (continued)**

DVB-GASOIL	DESULPHURISED VISBREAKER GASOIL
DVC-GASOIL	DESULPHURISED VACUUM GASOIL
FCC-GAS	FLUID CATALYTIC CRACKING GAS (ALL CRUDES)
FG-COKE	FUEL GRADE COKE
FLV-GASOIL	FLEXICOKER VACUUM GASOIL
FLX-GASOIL	FLEXICOKER GASOIL
FLX-GAS	FLEXICOKER GAS (ONLY IL+AH-CRUDE)
H-CY-OIL	HEAVY CYCLE OIL
H-CRACKATE	HEAVY HYDROCRACKATE
H2	HYDROGEN
H2S	HYDROSULFIDE
HCR-GASOIL	HYDROCRACKER GASOIL
HCR-KEROSE	(RESIDUE) HYDROCRACKER KEROSENE
IC4-GP	ISOBUTANE-STREAM FROM GAS-PLANT
IC4	ISO-BUTANE
ISOMERATE	ISOMERATE
L-CRACKATE	LIGHT HYDROCRACKATE
L-CY-OIL	LIGHT CYCLE OIL
LUBR+WAXES	LUBRICANTS + WAXES
METH-TBA	METHANOL AND TBA MIX
MTBE	MTBE1
MTBE-EXTR	MTBE2
NAPHTA+LE	STRAIGHT-RUN NAPHTHA & LIGHT ENDS
NATURALGAS	NATURAL GAS
NC4	N-BUTANE
NC4-GP	NBUTANE-STREAM FROM GAS-PLANT
PRO+BUTENE	PROPENE + BUTENE
RAFFINATE	RAFFINATE
RDS-GASOIL	RESIDUE HYDRODESULPHURISED GASOIL (RESID-HDS GAS OIL)
REF-GAS-U	REFINERY GAS FOR UTILITIES (PJ)
REF-OIL-U	REFINERY FUEL OIL FOR UTILITIES (PJ)
REFORM100	REFORMATE 100 RON
REFORM93	REFORMATE 93 RON
RHC-RESID	RESIDUE-HYDROCRACKING RESIDUE
RHC-GASOIL	RESIDUE HYDROCRACKER GASOIL
S	SULPHUR
S-KEROSENE	STRAIGHT-RUN KEROSENE
SH-GASOIL	HEAVY STRAIGHT-RUN GASOIL
SH-NAPHTA	HEAVY STRAIGHT-RUN NAPHTHTA
SL-NAPHTA	LIGHT STRAIGHT-RUN NAPHTHTA
SL-GASOIL	LIGHT STRAIGHT-RUN GASOIL
STEAM-P	STEAM PRODUCED IN THE REFINERY PROCESSES (OUTPUT)

LIST OF PROCESLABELS IN TABLES

* **Intermediate products (continued)**

VAC-GASOIL	VACUUM GASOIL
VAC-RES-D	DE-SULPHURISED VACUUM RESIDUE
VAC-RESID	VACUUM RESIDUE
VB-GASOLIN	VISBREAKER GASOLINE
VB-NAPHTA	VISBREAKER NAPHTHTA
VBA-GASOIL	VISBREAKER GASOIL FROM ATMOSPHERIC FEED
VBA-RESID	VISBREAKER RESIDUE FROM ATMOSPHERIC FEED
VBV-GASOIL	VISBREAKER GASOIL FROM VACUUM FEED
VBV-RESID	VISBREAKER RESIDUE FROM VACUUM FEED

* **Final products**

PG-COKE	PREMIUM GRADE COKE
EVC-GASOIL	EXPORT VACUUM-GASOIL
PREMIUM-LD	LEADED PREMIUM
PREMIUM-LL	LOW-LEADED PREMIUM
PREMIUM-UL	UNLEADED PREMIUM
REGULAR-LD	LEADED REGULAR
REGULAR-LL	LOW-LEADED REGULAR
REGULAR-UL	UNLEADED REGULAR
AUTODIESEL	AUTO DIESEL
OTH-GASOIL	OTHER GASOIL
H-FUEL-OIL	HEAVY FUEL OIL
BUNKER-OIL	HEAVY BUNKER FUEL OIL
KEROSENE	KEROSENE
P-NAPHTA	NAPHTHA FOR THE PETROCHEMICAL INDUSTRY
REF-OIL	REFINERY FUEL OIL (FOR OWN USE ONLY)
REF-GAS	REFINERY GAS (MOSTLY SELF-CONSUMPTION)
ASPHALT	ASPHALT
LPG	LIQUID PETROLEUM GAS

* **Emissions**

CH	HYDROCARBONS
NOX	NITRO OXYGENATES
PART	PARTICULARS
SO2	SULPHUR DIOXYDE

LIST OF PROCESLABELS IN TABLES

*** Crude oil tags**

AH	ARABIAN HEAVY
BB	BRENT BLEND
IL	IRANIAN LIGHT
NT	NO TAG
SB	SAHARA BLEND

DIFFERENT DATA

* **Blending qualities**

CETANE	CETANE NUMBER
CONRAD	CONRAD CARBON CONTENT
E100LO	E100 POINT - LOWER BOUND
E100UP	E100 POINT - UPPER BOUND
MON	MOTOR OCTANE NUMBER
POUR	POURPOINT NUMBER
RON	RESEARCH OCTANE NUMBER
SGLO	DENSITY -LOWER BOUND
SGUP	DENSITY -UPPER BOUND
SULFUR	SULFUR CONTENT
VAPOURLO	REID VAPOUR PRESSURE - LOWER BOUND
VAPOURUP	REID VAPOUR PRESSURE - UPPER BOUND
VISCOS	VISCOSITY NUMBER

* **Octane rates**

MON	MOTOR OCTANE NUMBER
RON	RESEARCH OCTANE NUMBER

* **Lead tags of benzines**

LD	LEADED BENZINE
LL	LOW-LEADED BENZINE
UL	UNLEADED BENZINE

DATA CONCERNING UNITS

* CAPACITY 10**6 TON/YEAR	LOWER	UPPER	CAPCOST FL/TON	FIXCOST FL/TON	ANFAC
ALKYLATION	0	+INF	380.00	12.6	0.0899
ATSR	0	+INF	470.00	39.18	0.0899
ATSR-TGU	0	INF	700.00	53.42	0.0899
C4-ISO	0	INF	210.00	7.67	0.0899
C56-ISO	0	INF	210.00	7.95	0.0899
CATCRACK-1	0	+INF	290.00	3.56	0.0899
CATCRACK-2	0	+INF	290.00	3.56	0.0899
CATCRACK-3	0	+INF	290.00	3.56	0.0899
CREF-HCR-1	0	+INF	130.00	4.38	0.0899
CREF-HCR-2	0	+INF	130.00	4.38	0.0899
CREF-NAP-1	0	+INF	130.00	4.38	0.0899
CREF-NAP-2	0	+INF	130.00	4.38	0.0899
CRUDE-DIST	0	+INF	50.00	0.79	0.0899
DELAYCK-1	0	INF	350.00	4.93	0.0899
DELAYCK-2	0	INF	350.00	4.93	0.0899
FLEXICOKER	0	INF	260.00	3.01	0.0899
GAS-PLANT	0	+INF	130.00	4.11	0.0899
HT-CK-NAP	0	+INF	50.00	1.37	0.0899
HT-CKR-GO	0	+INF	75.00	3.29	0.0899
HT-CY-OIL	0	+INF	75.00	3.01	0.0899
HT-FIN-DEL	0	+INF	70.00	3.29	0.0899
HT-FIN-FLX	0	+INF	70.00	3.29	0.0899
HT-HSR-GO	0	+INF	60.00	2.47	0.0899
HT-KEROS	0	+INF	50.00	1.92	0.0899
HT-LSR-GO	0	+INF	60.00	2.47	0.0899
HT-SR-NAP	0	+INF	32.00	1.37	0.0899
HT-VAC-GO	0	+INF	75.00	3.29	0.0899
HT-VB-NAP	0	+INF	50.00	1.37	0.0899
HT-VIS-GO	0	+INF	75.00	3.01	0.0899
HYCRACK-KE	0	INF	330.00	4.66	0.0899
HYCRACK-MD	0	INF	330.00	4.66	0.0899
HYCRACK-MG	0	INF	330.00	4.66	0.0899
HYDROGEN-P	0	+INF	2100.00	5.48	0.0899
LUBEOIL-PL	0	+INF	400.00	12.33	0.0899
RES-HCRACK	0	INF	470.00	10.14	0.0899
RES-HDS-VC	0	INF	240.00	5.48	0.0899
RES-HDS-AT	0	INF	200.00	4.11	0.0899
SOLV-DEASP	0	INF	280.00	3.84	0.0899
VAC-DIST	0	+INF	33.00	2.47	0.0899
VB-VACRES	0	+INF	85.00	1.37	0.0899
VB-ATMRES	0	+INF	70.00	1.37	0.0899

DATA CONCERNING UNITS (continued)

	LOWER	UPPER	CAPCOST	FIXCOST	ANFAC
*	-----	-----	-------	-------	-----
* CAPACITY IN MWT			FL/MWT		
BOILER-CO	0	+INF	.480		0.12333
BOILER-FC	0	+INF	.140		0.12333
BOILER-FL	0	+INF	.140		0.12333
BOILER-NG	0	+INF	.140		0.12333
BOILER-PC	0	+INF	.500		0.12333
BOILER-RG	0	+INF	.140		0.12333
BOILER-RO	0	+INF	.180		0.12333
CLEAN-FC	0	+INF	.001		0.12333
FURNACE-FL	0	+INF			
FURNACE-NG	0	+INF			
FURNACE-RG	0	+INF			
FURNACE-RO	0	+INF			
GAS-RO	0	+INF	.500		0.12333
* CAPACITY IN MWE			FL/MWE		
BACKP-CO	0	INF	6.989		0.1233
BACKP-RO	0	INF	3.360		0.1233
BACKP-TURB	0	INF	2.823		0.1233
COMB-CYCLE	0	INF	1.400		0.1233
COND-TURB	0	INF	1.600		0.1233
DISTRIBUTE	0	INF			
GASTURBINE	0	INF	1.275		0.1233

OCTANE BLENDING VALUES

*			RON.UL	RON.LL	RON.LD	MON.UL	MON.LL	MON.LD
((SB,BB)	.SL-NAPHTA	)	71	77	82	69	75	80
((IL,AH)	.SL-NAPHTA	)	63	69	74	60	66	71
(NT	.REFORM93	)	93	96	99	84	87	89
(NT	.REFORM100	)	100	102	103	88	90	92
(NT	.L-CRACKATE	)	83	90	95	82	89	94
(NT	.H-CRACKATE	)	68	75	81	67	74	79
(NT	.CR-NAPHTA1	)	91	93	94	80	81	82
(NT	.CR-NAPHTA2	)	92	94	95	81	82	83
(NT	.CR-NAPHTA3	)	93	95	96	82	83	84
(NT	.VB-GASOLIN	)	80	85	88	73	75	78
(NT	.CK-GASOLIN	)	67	72	75	62	66	70
(NT	.ISOMERATE	)	90	94	98	88	97	103
(NT	.ALKYLATE	)	94	98	101	91	96	11
(NT	.(NC4,NC4-GP)	)	94	97	100	90	95	99
(NT	.RAFFINATE	)	63	73	81	64	73	79
(NT	.METH-TBA	)	119	121		99	101	
(NT	.(MTBE,MTBE-EXTR)	)	114	116		99	102	

SULFUR BLENDING VALUES

*	SB	BB	IL	AH	NT
ALKYL-TAR					0.01
ASPHALT-R			5.3	7.3	
ATM-RES-D			0.3	0.6	
ATM-RESID	0.2	0.8	2.4	4.3	
D-KEROSENE					0.01
DCK-GASOIL			0.03	0.05	
DL-CY-OIL	0.1	0.1	0.2	0.4	
DSH-GASOIL			0.1	0.1	
DSL-GASOIL	0.01	0.01	0.01	0.1	
DVB-GASOIL			0.3	0.5	
DVC-GASOIL			0.3	0.5	
H-CY-OIL	0.4	1.7	4.2	7.0	
HCR-KEROSE					0.01
HCR-GASOIL	0.01	0.01	0.03	0.05	
L-CY-OIL	0.2	0.6	1.7	2.8	
RDS-GASOIL			0.2	0.2	
RHC-GASOIL			0.2	0.3	
RHC-RESID			1.5	2.1	
S-KEROSENE	0.01	0.1	0.2	0.2	
SH-GASOIL	0.1	0.3	1.1	1.5	
SL-GASOIL	0.1	0.1	0.7	1.3	
VAC-RESID	0.4	1.3	3.7	5.9	
VAC-GASOIL	0.2	0.6	1.8	3.0	
VAC-RES-D			0.8	1.1	
VBA-GASOIL			1.5	2.6	
VBV-GASOIL			1.7	3.7	
VBA-RESID			2.6	4.6	
VBV-RESID			4	6.4	

BLENDING DATA ABOUT SPECIFIC GRAVITY

*	SB	BB	IL	AH	NT
	--	--	--	--	--
(MTBE,MTBE-EXTR)					0.750
(NC4,NC4-GP)					0.580
ALKYL-TAR					0.759
ALKYLATE					0.700
ASPHALT-R			1.081	1.081	
ATM-RESID	0.900	0.923	0.953	0.981	
ATM-RES-D			0.920	0.920	
CK-GASOLIN					0.750
CR-NAPHTA1					0.750
CR-NAPHTA2					0.750
CR-NAPHTA3					0.750
D-KEROSENE					0.791
DCK-GASOIL			0.852	0.852	
DL-CY-OIL	0.910	0.910	0.910	0.910	
DSH-GASOIL			0.850	0.838	
DSL-GASOIL	0.830	0.830	0.829	0.838	
DVB-GASOIL			0.835	0.880	
DVC-GASOIL			0.896	0.908	
H-CY-OIL	0.980	0.980	1.080	1.080	
H-CRACKATE					0.780
HCR-GASOIL	0.820	0.820	0.820	0.820	
HCR-KEROSE					0.791
ISOMERATE					0.670
L-CY-OIL	0.901	0.901	0.930	0.930	
L-CRACKATE					0.670
METH-TBA					0.790
RAFFINATE					0.660
RDS-GASOIL			0.860	0.860	
REFORM100					0.820
REFORM93					0.800
RHC-GASOIL			0.880	0.889	
RHC-RESID			1.080	1.073	
S-KEROSENE	0.796	0.803	0.803	0.791	
SH-GASOIL	0.853	0.861	0.860	0.848	
SL-GASOIL	0.831	0.839	0.839	0.848	
SL-NAPHTA	0.670	0.670	0.670	0.670	
VAC-RES-D			0.970	0.980	
VAC-RESID	0.952	0.989	1.021	1.051	
VAC-GASOIL	0.890	0.885	0.916	0.928	
VB-GASOLIN					0.750
VBV-GASOIL			0.855	0.900	
VBA-GASOIL			0.858	0.906	
VBA-RESID			0.967	1.002	
VBV-RESID			1.043	1.075	

PRODUCER	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
PLANT	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
UNIT	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
*	CR-DIST-SB.SB	CR-DIST-BB.BB	CR-DIST-IL.IL	CR-DIST-AH.AH
* COSTDATA (F/T)				
VAR-COSTS	0.02	0.02	0.02	0.02
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
CRUDE	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-48	-46	-44	-35
HEAT	-.6	-.55	-.5	-.4
POWER	-4.8	-4.6	-4.4	-3.5
COOLING-W	-.4	-.4	-.4	-.3
* PRODUCT-YIELD(PERCENTAGE)				
NAPHTA+LE	.30	.27	.22	.18
S-KEROSENE	.14	.10	.11	.08
SL-GASOIL	.11	.10	.10	.09
SH-GASOIL	.10	.10	.09	.07
ATM-RESID	.35	.43	.48	.58
+				

PRODUCER	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
PLANT	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
UNIT	CRUDE-DIST	CRUDE-DIST	CRUDE-DIST
*	CR-DIST-CD.BB	AR-DIST-IL.IL	AR-DIST-AH.AH
* COSTDATA (F/T)			
VAR-COSTS	0.02	0.02	0.02
UFAC	.93	.93	.93
* FEEDSTOCK			
CONDENSATE	-1		
ATM-R-FEED		-1	-1
* REQUIREMENTS			
STEAM	-50	-25	-25
HEAT	-.6	-.4	-.4
POWER	-6.0	-3.0	-3.0
COOLING-W	-.4	-.1	-.1
* PRODUCT-YIELD(PERCENTAGE)			
NAPHTA+LE	.95		
S-KEROSENE	.05		
SL-GASOIL			
SH-GASOIL		.05	.05
ATM-RESID		.95	.95
+			

```
=====================================================================
PRODUCER    VAC-DIST        VAC-DIST        VAC-DIST        VAC-DIST
PLANT       VAC-DIST        VAC-DIST        VAC-DIST        VAC-DIST
UNIT        VAC-DIST        VAC-DIST        VAC-DIST        VAC-DIST
=====================================================================

           VACDIST-SB.SB  VACDIST-BB.BB  VACDIST-IL.IL  VACDIST-AH.AH
*          =============  =============  =============  =============

*  COSTDATA
  VAR-COSTS     0.1             0.1             0.1             0.1
  UFAC           .93             .93             .93             .93

*  FEEDSTOCK
  ATM-RESID   -1              -1              -1              -1

*  REQUIREMENTS
  STEAM     -50             -50             -50             -50
  HEAT        -.5             -.5             -.5             -.5
  POWER     -1.8            -1.8            -1.8            -1.8
  COOLING-W -2              -2              -2              -2

*  PRODUCT-YIELD(PERCENTAGE)
  VAC-GASOIL     .82             .71             .68             .53
  VAC-RESID      .18             .29             .32             .47
 +
```

```
=========================================================================
PRODUCER      H2FINER         H2FINER
PLANT         H2FINER         H2FINER
UNIT          HT-FIN-FLX      HT-FIN-FLX
=========================================================================

              HTF-FVG-IL.IL  HTF-FVG-AH.AH
*             =============  =============

*  COSTDATA
  VAR-COSTS        0.80           0.80
  UFAC             1.18           0.93

*  FEEDSTOCK
  FLV-GASOIL     -1             -1

*  OTHER FEEDSTOCKS
  H2               -.022          -.023

*  REQUIREMENTS
  STEAM         -80            -80
  HEAT             -.4            -.4
  POWER         -15            -15
  COOLING-W       -2             -2

*  PRODUCT-YIELD(PERCENTAGE)
  H2S               .039           .060
  CK-GASOLIN        .030           .030
  DCK-GASOIL        .325           .318
  VAC-GASOIL        .628           .615
+
```

```
=========================================================================
PRODUCER      H2FINER         H2FINER
PLANT         H2FINER         H2FINER
UNIT          HT-FIN-DEL      HT-FIN-DEL
=========================================================================

              HTF-DVG-IL.IL  HTF-DVG-AH.AH
*             =============  =============

*  COSTDATA
  VAR-COSTS        0.80           0.80
  UFAC             1.18           0.93

*  FEEDSTOCK
  DLV-GASOIL     -1             -1

*  OTHER FEEDSTOCKS
  H2               -.022          -.023

*  REQUIREMENTS
  STEAM         -80            -80
  HEAT             -.4            -.4
  POWER         -15            -15
  COOLING-W       -2             -2

*  PRODUCT-YIELD(PERCENTAGE)
  H2S               .041           .059
  CK-GASOLIN        .030           .030
  DCK-GASOIL        .325           .318
  VAC-GASOIL        .628           .615
+
```

PRODUCER	H2TREATING	H2TREATING	H2TREATING	H2TREATING
PLANT	HTREAT-NAP	HTREAT-NAP	HTREAT-NAP	HTREAT-NAP
UNIT	HT-SR-NAP	HT-SR-NAP	HT-SR-NAP	HT-SR-NAP
*	HT-SRNAPSB.SB	HT-SRNAPBB.BB	HT-SRNAPIL.IL	HT-SRNAPAH.AH
* COSTDATA				
VAR-COSTS	0.1	0.1	0.1	0.1
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
NAPHTA+LE	-1	-1	-1	-1
* OTHER FEEDSTOCKS				
H2	-.002	-.002	-.002	-.002
* REQUIREMENTS				
STEAM	-20	-20	-20	-20
HEAT	-.5	-.5	-.5	-.5
POWER	-10	-10	-10	-10
COOLING-W	-2	-2	-2	-2
* PRODUCT-YIELD(PERCENTAGE)				
H2S			.0004	.00007
C1C2	.036	.028	.026	.035
C3	.021	.017	.015	.02
NC4	.05	.04	.037	.05
IC4	.016	.013	.012	.015
SL-NAPHTA	.234	.253	.265	.24
SH-NAPHTA	.644	.650	.646	.641
+				

PRODUCER	H2TREATING	H2TREATING
PLANT	HTREAT-NAP	HTREAT-NAP
UNIT	HT-CK-NAP	HT-VB-NAP
*	HT-CK-NAPH.NT	HT-VB-NAPH.NT
* COSTDATA		
VAR-COSTS	0.15	0.15
UFAC	.93	.93
* FEEDSTOCK		
CK-NAPHTA	-1	
VB-NAPHTA		-1
* OTHER FEEDSTOCKS		
H2	-.020	-.010
* REQUIREMENTS		
STEAM	-20	-20
HEAT	-.5	-.5
POWER	-10	-10
COOLING-W	-2	-2
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.016	.011
CK-GASOLIN	1.002	
VB-GASOLIN		.998
+		

PRODUCER	H2TREATING	H2TREATING	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH
UNIT	HT-KEROS	HT-KEROS	HT-KEROS	HT-KEROS
*	HT-KER-SB.SB	HT-KER-BB.BB	HT-KER-IL.IL	HT-KER-AH.AH
* COSTDATA				
VAR-COSTS	0.2	0.2	0.2	0.2
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
S-KEROSENE	-1	-1	-1	-1
* OTHER FEEDSTOCKS				
H2	-.002	-.002	-.002	-.002
* REQUIREMENTS				
STEAM	-80	-80	-80	-80
HEAT	-.4	-.4	-.4	-.4
POWER	-15	-15	-15	-15
COOLING-W	-2	-2	-2	-2
* PRODUCT-YIELD (PERCENTAGE)				
H2S			.002	.002
D-KEROSENE	1.01	1.01	.999	.999
+				

PRODUCER	H2TREATING	H2TREATING	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH
UNIT	HT-LSR-GO	HT-LSR-GO	HT-LSR-GO	HT-LSR-GO
*	HT-LGO-SB.SB	HT-LGO-BB.BB	HT-LGO-IL.IL	HT-LGO-AH.AH
* COSTDATA				
VAR-COSTS	0.6	0.6	0.6	0.6
UFAC	1.12	1.12	1.12	.93
* FEEDSTOCK				
SL-GASOIL	-1	-1	-1	-1
* OTHER FEEDSTOCKS				
H2	-.004	-.004	-.004	-.004
* REQUIREMENTS				
STEAM	-80	-80	-80	-80
HEAT	-.4	-.4	-.4	-.4
POWER	-15	-15	-15	-15
COOLING-W	-2	-2	-2	-2
* PRODUCT-YIELD (PERCENTAGE)				
H2S		.001	.007	.013
DSL-GASOIL	1.003	1.002	.996	.990
+				

PRODUCER	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH
UNIT	HT-HSR-GO	HT-HSR-GO
*	HT-HGO-IL.IL	HT-HGO-AH.AH
* COSTDATA		
VAR-COSTS	0.6	0.6
UFAC	1.12	.93
* FEEDSTOCK		
SH-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.005	-.005
* REQUIREMENTS		
STEAM	-80	-80
HEAT	-.4	-.4
POWER	-15	-15
COOLING-W	-2	-2
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.011	.015
DSH-GASOIL	.993	.989
+		

PRODUCER	H2TREATING	H2TREATING	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH	HTREAT-OTH
UNIT	HT-VIS-GO	HT-VIS-GO	HT-VIS-GO	HT-VIS-GO
*	HT-VBA-IL.IL	HT-VBA-AH.AH	HT-VBV-IL.IL	HT-VBV-AH.AH
* COSTDATA				
VAR-COSTS	0.7	0.7	0.7	0.7
UFAC	1.18	.93	1.18	.93
* FEEDSTOCK				
VBA-GASOIL	-1	-1		
VBV-GASOIL			-1	-1
* OTHER FEEDSTOCKS				
H2	-.008	-.008	-.008	-.008
* REQUIREMENTS				
STEAM	-80	-80	-80	-80
HEAT	-.4	-.4	-.4	-.4
POWER	-15	-15	-15	-15
COOLING-W	-2	-2	-2	-2
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.014	.028	.014	.028
DVB-GASOIL	.993	.979	.993	.979
+				

PRODUCER	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH
UNIT	HT-CKR-GO	HT-CKR-GO
*	HT-DCU-IL.IL	HT-DCU-AH.AH
* COSTDATA		
VAR-COSTS	0.8	0.8
UFAC	1.18	.93
* FEEDSTOCK		
DEL-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.024	-.026
* REQUIREMENTS		
STEAM	-80	-80
HEAT	-.4	-.4
POWER	-15	-15
COOLING-W	-2	-2
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.031	.059
DCK-GASOIL	.957	.931
CK-GASOLIN	.035	.035
+		

PRODUCER	H2TREATING	H2TREATING
PLANT	HTREAT-OTH	HTREAT-OTH
UNIT	HT-CKR-GO	HT-CKR-GO
*	HT-FCU-IL.IL	HT-FCU-AH.AH
* COSTDATA		
VAR-COSTS	0.8	0.8
UFAC	1.18	.93
* FEEDSTOCK		
FLX-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.024	-.026
* REQUIREMENTS		
STEAM	-80	-80
HEAT	-.4	-.4
POWER	-15	-15
COOLING-W	-2	-2
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.031	.059
DCK-GASOIL	.957	.931
CK-GASOLIN	.035	.035
+		

```
==========================================================================
PRODUCER     H2TREATING      H2TREATING
PLANT        HTREAT-OTH      HTREAT-OTH
UNIT         HT-VAC-GO       HT-VAC-GO
==========================================================================

             HT-VAC-IL.IL    HT-VAC-AH.AH
*            ============    ============

*  COSTDATA
  VAR-COSTS       0.7             0.7
  UFAC            1.18             .93

*  FEEDSTOCK
  VAC-GASOIL     -1              -1
*       FROM VDU , LOP

*  OTHER FEEDSTOCKS
  H2              -.006           -.007

*  REQUIREMENTS
  STEAM        -80             -80
  HEAT            -.4             -.4
  POWER        -15             -15
  COOLING-W     -2              -2

*  PRODUCT-YIELD(PERCENTAGE)
  H2S              .018            .029
  DVC-GASOIL       .984            .974
 +
```

```
==========================================================================================
PRODUCER     H2TREATING      H2TREATING      H2TREATING      H2TREATING
PLANT        HTREAT-OTH      HTREAT-OTH      HTREAT-OTH      HTREAT-OTH
UNIT         HT-CY-OIL       HT-CY-OIL       HT-CY-OIL       HT-CY-OIL
==========================================================================================

             HT-LCO-SB.SB    HT-LCO-BB.BB    HT-LCO-IL.IL    HT-LCO-AH.AH
*            ============    ============    ============    ============

*  COSTDATA
  VAR-COSTS       0.7             0.7             0.7             0.8
  UFAC            1.18            1.18            1.18             .93

*  FEEDSTOCK
  L-CY-OIL      -1              -1              -1              -1

*  OTHER FEEDSTOCKS
  H2              -.008           -.008           -.009           -.009

*  REQUIREMENTS
  STEAM        -80             -80             -80             -80
  HEAT            -.4             -.4             -.4             -.4
  POWER        -15             -15             -15             -15
  COOLING-W     -2              -2              -2              -2

*  PRODUCT-YIELD(PERCENTAGE)
  H2S              .002            .005            .015            .024
  DL-CY-OIL       1.005           1.002            .993            .984
 +
```

PRODUCER	C-REFORMER	C-REFORMER	C-REFORMER	C-REFORMER
PLANT	C-REFORMER	C-REFORMER	C-REFORMER	C-REFORMER
UNIT	CREF-NAPH1	CREF-NAPH1	CREF-NAPH1	CREF-HCR-1
*	REF-SRNAP1.NT	REF-CKNAP1.NT	REF-VBNAP1.NT	REF-HCR-1.NT
* COSTDATA				
VAR-COSTS	0.7	0.7	0.7	0.7
UFAC	1.2	1.2	1.2	1.2
* FEEDSTOCK				
SH-NAPHTA	-1			
CK-GASOLIN		-1		
VB-GASOLIN			-1	
H-CRACKATE				-1
* REQUIREMENTS				
STEAM	-65	-65	-65	-50
HEAT	-2.4	-2.4	-2.4	-2.0
POWER	-13	-13	-13	-10
COOLING-W	-2	-2	-2	-3
* PRODUCT-YIELD(PERCENTAGE)				
H2	.026	.026	.026	.011
C1C2	.02	.02	.02	.004
C3	.028	.028	.028	.012
NC4	.029	.029	.029	.017
IC4	.027	.027	.027	.013
REFORM93	.87	.87	.87	.943
+				

PRODUCER	C-REFORMER	C-REFORMER	C-REFORMER	C-REFORMER
PLANT	C-REFORMER	C-REFORMER	C-REFORMER	C-REFORMER
UNIT	CREF-NAPH2	CREF-NAPH2	CREF-NAPH2	CREF-HCR-2
*	REF-SRNAP2.NT	REF-CKNAP2.NT	REF-VBNAP2.NT	REF-HCR-2.NT
* COSTDATA				
VAR-COSTS	1.	1.	1.	1.
UFAC	.9	.9	.9	.9
* FEEDSTOCK				
SH-NAPHTA	-1			
CK-GASOLIN		-1		
VB-GASOLIN			-1	
H-CRACKATE				-1
* REQUIREMENTS				
STEAM	-80	-80	-80	-72
HEAT	-2.9	-2.9	-2.9	-2.7
POWER	-16	-16	-16	-14
COOLING-W	-3	-3	-3	-3
* PRODUCT-YIELD(PERCENTAGE)				
H2	.041	.041	.041	.033
C1C2	.033	.033	.033	.026
C3	.043	.043	.043	.034
NC4	.033	.033	.033	.029
IC4	.023	.023	.023	.02
REFORM100	.827	.827	.827	.858
+				

```
=====================================================================
PRODUCER      HYDROGEN-P
PLANT         HYDROGEN-P
UNIT          HYDROGEN-P
=====================================================================

              HYDROGEN-P.NT
*             =============

*  COSTDATA
  VAR-COSTS        1
  UFAC              .93

*  FEEDSTOCK
  NATURALGAS   -100

*  REQUIREMENTS
  HEAT          -75
  POWER        -150
  COOLING-W     -20

*  PRODUCT-YIELD(PERCENTAGE)
  H2               1
  STEAM-P         34
*     OUTPUT STEAM  IN  GJ  PER  100GJ  NATURALGAS FEED
 +
```

```
=====================================================================
PRODUCER     C56-ISO        C56-ISO        C56-ISO        C56-ISO
PLANT        C56-ISO        C56-ISO        C56-ISO        C56-ISO
UNIT         C56-ISO        C56-ISO        C56-ISO        C56-ISO
=====================================================================

            C56-ISO-SB.SB  C56-ISO-BB.BB  C56-ISO-IL.IL  C56-ISO-AH.AH
*           =============  =============  =============  =============

*  COSTDATA
  VAR-COSTS        .7             .7             .7             .7
  UFAC             .93            .93            .93            .93

*  FEEDSTOCK
  SL-NAPHTA      -1             -1             -1             -1

*  OTHER FEEDSTOCKS
  H2              -.002          -.002          -.002          -.002

*  REQUIREMENTS
  STEAM       -160           -160           -160           -160
  HEAT          -1.1           -1.1           -1.1           -1.1
  POWER        -26            -26            -26            -26

*  PRODUCT-YIELD(PERCENTAGE)
  C3               .004           .004           .004           .004
  IC4              .007           .007           .007           .007
  NC4              .019           .019           .019           .019
  ISOMERATE        .972           .972           .972           .972
 +
```

```
=====================================================================
PRODUCER      GAS-PLANT      GAS-PLANT      GAS-PLANT
PLANT         GAS-PLANT      GAS-PLANT      GAS-PLANT
UNIT          GAS-PLANT      GAS-PLANT      GAS-PLANT
=====================================================================

              GASPL-C3.NT    GASPL-NC4.NT   GASPL-IC4.NT
*             ===========    ============   ============

*  COSTDATA
  VAR-COSTS         .05            .05            .05
  UFAC              .93            .93            .93

*  FEEDSTOCK
  C3            -1
  NC4                          -1
  IC4                                         -1

*  REQUIREMENTS
  STEAM        -320           -320           -320
  POWER         -20            -20            -20
  COOLING-W      -1             -1             -1

*  PRODUCT-YIELD(PERCENTAGE)
  C3-GP          1
  NC4-GP                        1
  IC4-GP                                       1
 *
```

```
======================================================================
PRODUCER      C4-ISO
PLANT         C4-ISO
UNIT          C4-ISO
======================================================================

              C4-ISO.NT
*             =========

*  COSTDATA
  VAR-COSTS          .7
  UFAC               .93

*  FEEDSTOCK
  NC4-GP         -1

*  OTHER FEEDSTOCKS
  H2                 -.002

*  REQUIREMENTS
  STEAM        -140
  HEAT               -.4
  POWER          -12

*  PRODUCT-YIELD(PERCENTAGE)
  IC4-GP             .95
  ISOMERATE          .02
  C1C2               .03
 +
```

PRODUCER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER
UNIT	CATCRACK-1	CATCRACK-1
*	CAT1-AT-SB.SB	CAT1-AT-BB.BB
* COSTDATA		
VAR-COSTS	2.7	2.7
UFAC	1.1	1.1
* FEEDSTOCK		
ATM-RESID	-1	-1
* REQUIREMENTS		
STEAM	-100	-100
HEAT	-.4	-.4
POWER	-10	-10
COOLING-W	-15	-15
* PRODUCT-YIELD(PERCENTAGE)		
C1C2	.018	.018
PRO+BUTENE	.055	.055
C3	.010	.009
IC4	.023	.023
NC4	.009	.009
CR-NAPHTA1	.352	.351
L-CY-OIL	.375	.374
H-CY-OIL	.103	.103
FCC-GAS	.69	.69
* OUTPUT OF FCC-GASS IN GJ PER TON FEED		
H2S	.001	.004
+		

PRODUCER	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
UNIT	CATCRACK-1	CATCRACK-1	CATCRACK-1	CATCRACK-1
*	CAT1-VC-SB.SB	CAT1-VC-BB.BB	CAT1-VC-IL.IL	CAT1-VC-AH.AH
* COSTDATA				
VAR-COSTS	2.7	2.7	2.7	2.7
UFAC	1.1	1.1	1.1	1.1
* FEEDSTOCK				
VAC-GASOIL	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-100	-100	-100	-100
HEAT	-.4	-.4	-.4	-.4
POWER	-10	-10	-10	-10
COOLING-W	-15	-15	-15	-15
* PRODUCT-YIELD(PERCENTAGE)				
C1C2	.018	.017	.022	.018
PRO+BUTENE	.059	.060	.055	.055
C3	.009	.009	.009	.009
IC4	.023	.023	.023	.023
NC4	.008	.008	.009	.009
CR-NAPHTA1	.382	.381	.349	.349
L-CY-OIL	.369	.369	.371	.371
H-CY-OIL	.101	.101	.102	.102
FCC-GAS	.39	.39	.68	.68
* OUTPUT OF FCC-GASS IN GJ PER TON FEED				
H2S	.001	.002	.007	.011
+				

```
==========================================================================
PRODUCER      CATCRACKER      CATCRACKER
PLANT         CATCRACKER      CATCRACKER
UNIT          CATCRACK-1      CATCRACK-1
==========================================================================

              CAT1-DA-IL.IL  CAT1-DA-AH.AH
*             =============  ============

*  COSTDATA
  VAR-COSTS        2.7             2.7
  UFAC             1.1             1.1

*  FEEDSTOCK
  DA-OIL          -1              -1

*  REQUIREMENTS
  STEAM         -100            -100
  HEAT            -.4             -.4
  POWER          -10             -10
  COOLING-W      -15             -15

*  PRODUCT-YIELD(PERCENTAGE)
  C1C2                .022              .018
  PRO+BUTENE          .055              .055
  C3                  .009              .009
  IC4                 .023              .023
  NC4                 .009              .009
  CR-NAPHTA1          .349              .349
  L-CY-OIL            .371              .371
  H-CY-OIL            .102              .102
  FCC-GAS             .68               .68
*      OUTPUT  OF  FCC-GASS    IN  GJ  PER  TON  FEED
  H2S                 .007              .011
 +
```

```
==========================================================================
PRODUCER      CATCRACKER      CATCRACKER
PLANT         CATCRACKER      CATCRACKER
UNIT          CATCRACK-2      CATCRACK-2
==========================================================================

              CAT2-AT-SB.SB  CAT2-AT-BB.BB
*             =============  ============

*  COSTDATA
  VAR-COSTS         3.2             3.2
  UFAC              0.93            0.93

*  FEEDSTOCK
  ATM-RESID       -1              -1

*  REQUIREMENTS
  STEAM         -120            -120
  HEAT            -.5             -.5
  POWER          -12             -12
  COOLING-W      -17             -17

*  PRODUCT-YIELD(PERCENTAGE)
  C1C2                .038              .038
  PRO+BUTENE          .075              .075
  C3                  .014              .014
  IC4                 .031              .031
  NC4                 .014              .014
  CR-NAPHTA2          .427              .426
  L-CY-OIL            .265              .264
  H-CY-OIL            .072              .072
  FCC-GAS             .81               .80
*      OUTPUT  OF  FCC-GASS    IN  GJ  PER  TON  FEED
  H2S                 .001              .004
 +
```

PRODUCER	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
UNIT	CATCRACK-2	CATCRACK-2	CATCRACK-2	CATCRACK-2
*	CAT2-VC-SB.SB	CAT2-VC-BB.BB	CAT2-VC-IL.IL	CAT2-VC-AH.AH
* COSTDATA				
VAR-COSTS	3.2	3.2	3.2	3.2
UFAC	0.93	0.93	0.93	0.93
* FEEDSTOCK				
VAC-GASOIL	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-120	-120	-120	-120
HEAT	-.5	-.5	-.5	-.5
POWER	-12	-12	-12	-12
COOLING-W	-17	-17	-17	-17
* PRODUCT-YIELD(PERCENTAGE)				
C1C2	.031	.030	.041	.037
PRO+BUTENE	.084	.084	.075	.075
C3	.013	.013	.013	.013
IC4	.036	.036	.031	.031
NC4	.011	.011	.014	.013
CR-NAPHTA2	.468	.468	.423	.423
L-CY-OIL	.248	.248	.262	.262
H-CY-OIL	.071	.071	.072	.072
FCC-GAS	.47	.47	.80	.80
* OUTPUT OF FCC-GASS IN GJ PER TON FEED				
H2S	.001	.002	.007	.011
+				

PRODUCER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER
UNIT	CATCRACK-2	CATCRACK-2
*	CAT2-DA-IL.IL	CAT2-DA-AH.AH
* COSTDATA		
VAR-COSTS	3.2	3.2
UFAC	0.93	0.93
* FEEDSTOCK		
DA-OIL	-1	-1
* REQUIREMENTS		
STEAM	-120	-120
HEAT	-.5	-.5
POWER	-12	-12
COOLING-W	-17	-17
* PRODUCT-YIELD(PERCENTAGE)		
C1C2	.041	.037
PRO+BUTENE	.075	.075
C3	.013	.013
IC4	.031	.031
NC4	.014	.014
CR-NAPHTA2	.423	.423
L-CY-OIL	.262	.262
H-CY-OIL	.072	.072
FCC-GAS	.80	.80
* OUTPUT OF FCC-GASS IN GJ PER TON FEED		
H2S	.007	.011
+		

PRODUCER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER
UNIT	CATCRACK-3	CATCRACK-3
*	CAT3-AT-SB.SB	CAT3-AT-BB.BB
* COSTDATA		
VAR-COSTS	4.	4.
UFAC	0.8	0.8
* FEEDSTOCK		
ATM-RESID	-1	-1
* REQUIREMENTS		
STEAM	-140	-140
HEAT	-.6	-.6
POWER	-14	-14
COOLING-W	-20	-20
* PRODUCT-YIELD (PERCENTAGE)		
C1C2	.077	.076
PRO+BUTENE	.105	.105
C3	.020	.020
IC4	.041	.038
NC4	.018	.018
CR-NAPHTA3	.477	.476
L-CY-OIL	.138	.137
H-CY-OIL	.038	.038
FCC-GAS	1.09	1.09
* OUTPUT OF FCC-GASS IN GJ PER TON FEED		
H2S	.001	.004
+		

PRODUCER	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
PLANT	CATCRACKER	CATCRACKER	CATCRACKER	CATCRACKER
UNIT	CATCRACK-3	CATCRACK-3	CATCRACK-3	CATCRACK-3
*	CAT3-VC-SB.SB	CAT3-VC-BB.BB	CAT3-VC-IL.IL	CAT3-VC-AH.AH
* COSTDATA				
VAR-COSTS	4.	4.	4.	4.
UFAC	0.8	0.8	0.8	0.8
* FEEDSTOCK				
VAC-GASOIL	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-140	-140	-140	-140
HEAT	-.6	-.6	-.6	-.6
POWER	-14	-14	-14	-14
COOLING-W	-20	-20	-20	-20
* PRODUCT-YIELD (PERCENTAGE)				
C1C2	.054	.053	.080	.076
PRO+BUTENE	.113	.113	.104	.104
C3	.021	.021	.020	.020
IC4	.046	.046	.041	.041
NC4	.014	.014	.018	.018
CR-NAPHTA3	.542	.542	.472	.472
L-CY-OIL	.121	.121	.136	.136
H-CY-OIL	.037	.037	.038	.038
FCC-GAS	.65	.65	1.09	1.09
* OUTPUT OF FCC-GASS IN GJ PER TON FEED				
H2S	.001	.002	.007	.011
+				

```
=====================================================================
PRODUCER      CATCRACKER      CATCRACKER
PLANT         CATCRACKER      CATCRACKER
UNIT          CATCRACK-3      CATCRACK-3
=====================================================================

              CAT3-DA-IL.IL  CAT3-DA-AH.AH
*             ============   ============

*  COSTDATA
  VAR-COSTS        4.              4.
  UFAC             0.8             0.8

*  FEEDSTOCK
  DA-OIL          -1              -1

*  REQUIREMENTS
  STEAM        -140            -140
  HEAT            -.6             -.6
  POWER         -14             -14
  COOLING-W     -20             -20

*  PRODUCT-YIELD(PERCENTAGE)
  C1C2              .080            .076
  PRO+BUTENE        .104            .104
  C3                .020            .020
  IC4               .041            .041
  NC4               .018            .018
  CR-NAPHTA3        .472            .472
  L-CY-OIL          .136            .136
  H-CY-OIL          .038            .038
  FCC-GAS          1.09            1.09
*     OUTPUT OF FCC-GASS   IN GJ PER TON FEED
  H2S               .007            .011
 +
```

PRODUCER	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-MG	HYCRACK-MG
*	HCR1-VC-SB.SB	HCR1-VC-BB.BB
* COSTDATA		
VAR-COSTS	2.8	2.8
UFAC	1.19	1.19
* FEEDSTOCK		
VAC-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.035	-.036
* REQUIREMENTS		
STEAM	-39	-39
HEAT	-1.5	-1.5
POWER	-80	-80
COOLING-W	-10	-10
* PRODUCT-YIELD (PERCENTAGE)		
H2S	.002	.006
C1C2	.006	.006
C3	.033	.033
NC4	.04	.04
IC4	.077	.077
L-CRACKATE	.239	.239
H-CRACKATE	.635	.632
+		

PRODUCER	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-MG	HYCRACK-MG	HYCRACK-MG	HYCRACK-MG
*	HCR1-VC-IL.IL	HCR1-DA-IL.IL	HCR1-VC-AH.AH	HCR1-DA-AH.AH
* COSTDATA				
VAR-COSTS	2.8	2.8	2.8	2.8
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
VAC-GASOIL	-1		-1	
DA-OIL		-1		-1
* OTHER FEEDSTOCKS				
H2	-.044	-.044	-.045	-.045
* REQUIREMENTS				
STEAM	-50	-50	-50	-50
HEAT	-1.9	-1.9	-1.9	-1.9
POWER	-100	-100	-100	-100
COOLING-W	-13	-13	-13	-13
* PRODUCT-YIELD (PERCENTAGE)				
H2S	.019	.019	.031	.031
C1C2	.006	.006	.006	.006
C3	.033	.033	.032	.032
NC4	.037	.037	.036	.036
IC4	.072	.072	.072	.072
L-CRACKATE	.224	.224	.221	.221
H-CRACKATE	.65	.65	.644	.644
+				

PRODUCER	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-MD	HYCRACK-MD
*	HCR2-VC-SB.SB	HCR2-VC-BB.BB
* COSTDATA		
VAR-COSTS	3.7	3.7
UFAC	1.79	1.79
* FEEDSTOCK		
VAC-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.022	-.024
* REQUIREMENTS		
STEAM	-26	-26
HEAT	-1	-1
POWER	-55	-55
COOLING-W	-7	-7
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.002	.006
C1C2	.006	.006
C3	.01	.01
NC4	.012	.012
IC4	.018	.018
L-CRACKATE	.06	.06
H-CRACKATE	.14	.14
HCR-KEROSE	.154	.154
HCR-GASOIL	.617	.615

+

PRODUCER	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-MD	HYCRACK-MD	HYCRACK-MD	HYCRACK-MD
*	HCR2-VC-IL.IL	HCR2-DA-IL.IL	HCR2-VC-AH.AH	HCR2-DA-AH.AH
* COSTDATA				
VAR-COSTS	3.7	3.7	3.7	3.7
UFAC	1.4	1.4	1.4	1.4
* FEEDSTOCK				
VAC-GASOIL	-1		-1	
DA-OIL		-1		-1
* OTHER FEEDSTOCKS				
H2	-.029	-.029	-.03	-.03
* REQUIREMENTS				
STEAM	-33	-33	-33	-33
HEAT	-1.3	-1.3	-1.3	-1.3
POWER	-70	-70	-70	-70
COOLING-W	-9	-9	-9	-9
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.019	.019	.031	.031
C1C2	.006	.006	.006	.006
C3	.010	.010	.01	.01
NC4	.012	.012	.012	.012
IC4	.018	.018	.018	.018
L-CRACKATE	.059	.059	.062	.062
H-CRACKATE	.139	.139	.137	.137
HCR-KEROSE	.152	.152	.150	.150
HCR-GASOIL	.611	.611	.604	.604

+

PRODUCER	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-KE	HYCRACK-KE
*	HCR3-VC-SB.SB	HCR3-VC-BB.BB
* COSTDATA		
VAR-COSTS	3.4	3.3
UFAC	1.59	1.55
* FEEDSTOCK		
VAC-GASOIL	-1	-1
* OTHER FEEDSTOCKS		
H2	-.026	-.029
* REQUIREMENTS		
STEAM	-30	-31
HEAT	-1.2	-1.2
POWER	-63	-65
COOLING-W	-8	-8
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.002	.006
C1C2	.006	.006
C3	.018	.018
NC4	.021	.021
IC4	.038	.038
L-CRACKATE	.120	.120
H-CRACKATE	.305	.304
HCR-KEROSE	.514	.513
+		

PRODUCER	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
PLANT	HYD-CRACK	HYD-CRACK	HYD-CRACK	HYD-CRACK
UNIT	HYCRACK-KE	HYCRACK-KE	HYCRACK-KE	HYCRACK-KE
*	HCR3-VC-IL.IL	HCR3-DA-IL.IL	HCR3-VC-AH.AH	HCR3-DA-AH.AH
* COSTDATA				
VAR-COSTS	3.4	3.4	3.3	3.3
UFAC	1.22	1.22	1.21	1.21
* FEEDSTOCK				
VAC-GASOIL	-1		-1	
DA-OIL		-1		-1
* OTHER FEEDSTOCKS				
H2	-.035	-.035	-.036	-.036
* REQUIREMENTS				
STEAM	-40	-40	-40	-40
HEAT	-1.5	-1.5	-1.5	-1.5
POWER	-82	-82	-82	-82
COOLING-W	-11	-11	-11	-11
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.019	.019	.031	.031
C1C2	.006	.006	.006	.006
C3	.018	.018	.017	.017
NC4	.020	.020	.020	.020
IC4	.036	.036	.036	.036
L-CRACKATE	.114	.114	.115	.115
H-CRACKATE	.309	.309	.306	.306
HCR-KEROSE	.509	.509	.503	.503
+				

PRODUCER	RESID-UPGR	RESID-UPGR	RESID-UPGR	RESID-UPGR
PLANT	VISBREAKER	VISBREAKER	VISBREAKER	VISBREAKER
UNIT	VB-ATMRES	VB-ATMRES	VB-VACRES	VB-VACRES
*	VIS-ATR-IL.IL	VIS-ATR-AH.AH	VIS-VCR-IL.IL	VIS-VCR-AH.AH
* COSTDATA				
VAR-COSTS	.25	.25	.25	.25
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
ATM-RESID	-1	-1		
VAC-RESID			-1	-1
* REQUIREMENTS				
STEAM	-80	-80	-80	-80
HEAT	-1	-1	-1	-1
POWER	-6	-6	-6	-6
COOLING-W	-5	-5	-5	-5
* PRODUCT-YIELD (PERCENTAGE)				
H2S	.002	.002	.003	.004
C1C2	.012	.011	.008	.005
C3	.007	.007	.005	.003
NC4	.007	.006	.004	.003
VB-NAPHTA	.062	.054	.04	.035
VBA-GASOIL	.10	.11		
VBV-GASOIL			.12	.13
VBA-RESID	.81	.81		
VBV-RESID			.82	.82
+				

PRODUCER	RESID-UPGR	RESID-UPGR
PLANT	FLEXICOKER	FLEXICOKER
UNIT	FLEXICOKER	FLEXICOKER
*	FLEXICO-IL.IL	FLEXICO-AH.AH
* COSTDATA		
VAR-COSTS	.6	.6
UFAC	.93	.93
* FEEDSTOCK		
VAC-RESID	-1	-1
* REQUIREMENTS		
STEAM	-300	-300
POWER	-85	-85
COOLING-W	-12	-12
* PRODUCT-YIELD (PERCENTAGE)		
STEAM-P	1.7000	1.9200
H2S	.0220	.0380
C1C2	.0500	.0500
C3	.0400	.0400
NC4	.0210	.0210
IC4	.0080	.0080
CK-NAPHTA	.1320	.1320
FLX-GASOIL	.1570	.1360
FLV-GASOIL	.2840	.2470
FLX-GAS	7.7	8.8

* FLX-GAS AND STEAM-P OUTPUT IN GJ PER TON FEED

\+

PRODUCER	RESID-UPGR	RESID-UPGR	RESID-UPGR	RESID-UPGR
PLANT	DELAYCOKER	DELAYCOKER	DELAYCOKER	DELAYCOKER
UNIT	DELAYCK-1	DELAYCK-1	DELAYCK-1	DELAYCK-1
*	DELAY-1-SB.SB	DELAY-1-BB.BB	DELAY-1-IL.IL	DELAY-1-AH.AH
* COSTDATA				
VAR-COSTS	.75	.75	.75	.75
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
VAC-RESID	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-100	-100	-100	-100
HEAT	-1.1	-1.1	-1.1	-1.1
POWER	-12	-12	-12	-12
COOLING-W	-15	-15	-15	-15
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.001	.004	.012	.019
C1C2	.034	.041	.046	.046
C3	.02	.023	.027	.026
NC4	.014	.014	.015	.014
IC4	.006	.006	.006	.006
CK-NAPHTA	.215	.208	.217	.181
DEL-GASOIL	.166	.145	.109	.109
DLV-GASOIL	.386	.337	.253	.254
PG-COKE	.158	.222		
* PG COKES OUTPUTS IN TON PER TON FEED				
FG-COKE			11.025	12.075
* FG COKES OUTPUTS IN GJ PER TON FEED				
+				

PRODUCER	RESID-UPGR	RESID-UPGR	RESID-UPGR	RESID-UPGR
PLANT	DELAYCOKER	DELAYCOKER	DELAYCOKER	DELAYCOKER
UNIT	DELAYCK-2	DELAYCK-2	DELAYCK-2	DELAYCK-2
*	DELAY-2-SB.SB	DELAY-2-BB.BB	DELAY-2-IL.IL	DELAY-2-AH.AH
* COSTDATA				
VAR-COSTS	.75	.75	.75	.75
UFAC	.93	.93	.93	.93
* FEEDSTOCK				
VAC-RESID	-1	-1	-1	-1
* REQUIREMENTS				
STEAM	-100	-100	-100	-100
HEAT	-1.1	-1.1	-1.1	-1.1
POWER	-12	-12	-12	-12
COOLING-W	-15	-15	-15	-15
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.001	.004	.012	.019
C1C2	.048	.048	.053	.053
C3	.027	.028	.030	.03
NC4	.017	.016	.017	.016
IC4	.008	.007	.007	.008
CK-NAPHTA	.259	.241	.243	.222
DEL-GASOIL	.125	.1065	.072	.068
DLV-GASOIL	.291	.2485	.167	.158
PG-COKE	.224	.301		
* PG COKES OUTPUTS IN TON PER TON FEED				
FG-COKE			13.965	14.91
* FG COKES OUTPUTS IN GJ PER TON FEED				
+				

```
=================================================================
PRODUCER      RESID-UPGR     RESID-UPGR
PLANT         LUBRIC-OIL     LUBRIC-OIL
UNIT          LUBRIC-OIL     LUBRIC-OIL
=================================================================

              LUBEOIL-IL.IL  LUBEOIL-AH.AH
*             ============   ============

*  COSTDATA
  VAR-COSTS        2.             2.
  UFAC              .93            .93

*  FEEDSTOCK
  ATM-RESID       -1             -1

*  REQUIREMENTS
  STEAM        -750           -750
  HEAT           -1.8           -1.8
  POWER         -27            -27
  COOLING-W     -40            -40

*  PRODUCT-YIELD(PERCENTAGE)
  LUBR+WAXES        .47            .36
  VAC-GASOIL        .19            .16
  ASPHALT-R         .34            .48
 +
```

```
=================================================================
PRODUCER      RESID-UPGR     RESID-UPGR
PLANT         SOLV-DEASP     SOLV-DEASP
UNIT          SOLV-DEASP     SOLV-DEASP
=================================================================

              SOLV-DA-IL.IL  SOLV-DA-AH.AH
*             ============   ============

*  COSTDATA
  VAR-COSTS         .75            .75
  UFAC              .93            .93

*  FEEDSTOCK
  VAC-RESID       -1             -1

*  REQUIREMENTS
  STEAM        -275           -275
  HEAT             -.4            -.4
  POWER          -13            -13
  COOLING-W      -15            -15

*  PRODUCT-YIELD(PERCENTAGE)
  ASPHALT-R         .55            .69
  DA-OIL            .45            .31
 +
```

PRODUCER	RESID-UPGR	RESID-UPGR	RESID-UPGR	RESID-UPGR
PLANT	RESID-HDS	RESID-HDS	RESID-HDS	RESID-HDS
UNIT	RES-HDS-AT	RES-HDS-AT	RES-HDS-VC	RES-HDS-VC
*	RHDS-AT-IL.IL	RHDS-AT-AH.AH	RHDS-VC-IL.IL	RHDS-VC-AH.AH
* COSTDATA				
VAR-COSTS	19.2	19.2	26.3	26.3
UFAC	1.12	.93	1.12	.93
* FEEDSTOCK				
ATM-RESID	-1	-1		
VAC-RESID			-1	-1
* OTHER FEEDSTOCKS				
H2	-.011	-.016	-.014	-.02
* REQUIREMENTS				
STEAM	-350	-350	-350	-350
HEAT	-2.5	-2.5	-2.5	-2.5
POWER	-20	-20	-20	-20
COOLING-W	-4	-4	-4	-4
* PRODUCT-YIELD(PERCENTAGE)				
H2S	.023	.041	.032	.053
C1C2	.012	.025		
C3	.006	.01		
NC4	.005	.006		
IC4	.002	.003		
H-CRACKATE	.01	.009		
RDS-GASOIL	.07	.207	.049	.05
ATM-RES-D	.88	.712		
VAC-RES-D			.93	.914
+				

PRODUCER	RESID-UPGR	RESID-UPGR
PLANT	RESID-HCR	RESID-HCR
UNIT	RES-HCRACK	RES-HCRACK
*	RES-HCR-IL.IL	RES-HCR-AH.AH
* COSTDATA		
VAR-COSTS	15.7	15.7
UFAC	.93	.93
* FEEDSTOCK		
VAC-RESID	-1	-1
* OTHER FEEDSTOCKS		
H2	-.024	-.023
* REQUIREMENTS		
HEAT	-.4	-.4
POWER	-70	-70
COOLING-W	-2	-2
* PRODUCT-YIELD(PERCENTAGE)		
H2S	.030	.052
C1C2	.007	.007
C3	.013	.013
NC4	.013	.013
IC4	.009	.009
L-CRACKATE	.028	.023
H-CRACKATE	.029	.023
HCR-KEROSE	.167	.118
RHC-GASOIL	.200	.136
VAC-GASOIL	.275	.367
RHC-RESID	.253	.262
+		

```
=====================================================================
PRODUCER      ALKYLATION
PLANT         ALKYLATION
UNIT          ALKYLATION
=====================================================================

              ALKYLATION.NT
*             ============

*  COSTDATA
  VAR-COSTS       14.
  EFFICIENCY
  UFAC              .93

*  FEEDSTOCK
  PRO+BUTENE      -1

*  OTHER FEEDSTOCKS
  IC4-GP          -1.34

*  REQUIREMENTS
  STEAM          -96
  HEAT           -17
  POWER          -70
  COOLING-W      -70

*  PRODUCT-YIELD(PERCENTAGE)
  ALKYLATE        2.13
  C3-GP            .11
  NC4-GP           .08
  ALKYL-TAR        .02
 +
```

```
=====================================================================
PRODUCER      AM-SULFREC     AM-SULFREC
PLANT         AM-SULFREC     AM-SULFREC
UNIT          ATSR           ATSR
=====================================================================

              ATSR.NT        ATSR-TGU.NT
*             =======        ===========

*  COSTDATA
  VAR-COSTS        .1             2.6
  EFFICIENCY      1.              1.
  UFAC             .93             .93

*  FEEDSTOCK
  PRO+BUTENE
  H2S            -1             -1

*  REQUIREMENTS
  HEAT             -.7            -1.2
  POWER          -70            -80
  COOLING-W       -2             -2

*  PRODUCT-YIELD(PERCENTAGE)
  S                .89            .93
  STEAM-P         4.42           5.10
*    STEAM  OUTPUT  IN   GJ   PER   TON   FEED

*  ENVIRONMENTAL EFFECTS (T/10**6 TON FEED)
  SO2         94000          19000
*       0.094 TON/TON FEED  =  94000 TON/10**6 TON FEED.
 +
```

```
=====================================================================
PRODUCER      BLENDING        BLEND-CONV      BLEND-CONV
PLANT         BLENDING        BLEND-CONV      BLEND-CONV
UNIT          BLENDING        BLEND-CONV      BLEND-CONV
=====================================================================

              BLENDING.NT     BLENCO-RO.NT    BLENCO-RG.NT
*             ===========     ============    ============

  UFAC              1               1               1

*  FEEDSTOCK
  REF-OIL                          -1
  REF-GAS                                          -1

*  CONVERSION
  REF-OIL-U                        41
  REF-GAS-U                                        46
*              OUTPUTS IN GJ PER TON FEED    (IN PJ PER 10**6 TON FEED)

 TABLE INOUT2(MPRL,MEPP,MTAGS) UTILITIES-DATABASE      (EENHEID : PJ)
```

```
======================================================================
PRODUCER      UTILCLEAN
PLANT         GASIFIER
UNIT          GAS-RO
======================================================================

              GAS-RO.NT
*             ==========

* COSTDATA
  VAR-COSTS        1.0
  EFFICIENCY       0.95
  UFAC             0.0214

*  FEEDSTOCK
  REF-OIL-U       -1

*  CONVERSION
  REF-GAS-U        0.87
  STEAM-P          0.13
  H2S              0.0007
* OUTPUT H2S IN MLN TON/PJ
 +
```

```
======================================================================
PRODUCER      UTILCLEAN       UTILCLEAN       UTILCLEAN       UTILCLEAN
PLANT         CLEANCRACK      CLEANCRACK      CLEANCRACK      CLEANCRACK
UNIT          CLEAN-FC        CLEAN-FC        CLEAN-FC        CLEAN-FC
======================================================================

              CLEAN-FCSB.SB   CLEAN-FCBB.BB   CLEAN-FCIL.IL   CLEAN-FCAH.AH
*             ============    ============    ============    ============

* COSTDATA
  VAR-COSTS        0.4             1.6             4.8             8.2
  EFFICIENCY       1               1               1               1
  UFAC             0.0214          0.0214          0.0214          0.0214

*  FEEDSTOCK
  FCC-GAS         -1              -1              -1              -1

*  CONVERSION
  DFC-GAS          1.00            1.00            1.00            1.00
  H2S              0.0002          0.0008          0.0024          0.0041
* OUTPUT H2S IN  MLN TON/PJ
 +
```

PRODUCER	UTILITIES	UTILITIES	UTILITIES	UTILITIES
PLANT	BOILERS	BOILERS	BOILERS	BOILERS
UNIT	BOILER-NG	BOILER-RG	BOILER-RO	BOILER-FL
	BOILER-NG.NT	BOILER-RG.NT	BOILER-RO.NT	BOILER-FL.NT
* COSTDATA				
VAR-COSTS	.2	.2	.3	.2
ABATM-COST				
EFFICIENCY	.9	.9	.875	.9
UFAC	.0214	.0214	.0214	.0214
* FEEDSTOCK				
NATURALGAS	-1			
REF-GAS-U		-1		
REF-OIL-U			-1	
FLX-GAS				-1
* PRODUCT-YIELD(PERC)				
STEAM	1	1	1	1
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2		10	1463	50
NOX	70	69	102	80

PRODUCER	UTILITIES	UTILITIES
PLANT	BOILERS	BOILERS
UNIT	BOILER-CO	BOILER-PC
	BOILER-CO.NT	BOILER-PC.NT
* COSTDATA		
VAR-COSTS	.88	.3
ABATM-COST		
EFFICIENCY	.85	.85
UFAC	.0214	.0214
* FEEDSTOCK		
COAL	-1	
FG-COKE		-1
* PRODUCT-YIELD(PERC)		
STEAM	1	1
* ENVIRONMENTAL EFFECTS (T/PJ)		
SO2	684	2292
NOX	150	300

PRODUCER	UTILITIES	UTILITIES	UTILITIES	UTILITIES
PLANT	BOILERS	BOILERS	BOILERS	BOILERS
UNIT	BOILER-FC	BOILER-FC	BOILER-FC	BOILER-FC
*	BOIL-FCCSB.SB	BOIL-FCCBB.BB	BOIL-FCCIL.IL	BOIL-FCCAH.AH
* COSTDATA				
VAR-COSTS	.2	.2	.2	.2
ABATM-COST				
EFFICIENCY	.9	.9	.9	.9
UFAC	.0214	.0214	.0214	.0214
* FEEDSTOCK				
FCC-GAS	-1	-1	-1	-1
* PRODUCT-YIELD(PERC)				
STEAM	1	1	1	1
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2	258	1030	3070	5100
NOX	500	500	500	500
+				

PRODUCER	UTILITIES	UTILITIES	UTILITIES	UTILITIES
PLANT	BOILERS	BOILERS	BOILERS	BOILERS
UNIT	BOILER-FC	BOILER-FC	BOILER-FC	BOILER-FC
*	BOIL-DFCSB.SB	BOIL-DFCBB.BB	BOIL-DFCIL.IL	BOIL-DFCAH.AH
* COSTDATA				
VAR-COSTS	.2	.2	.2	.2
ABATM-COST				
EFFICIENCY	.9	.9	.9	.9
UFAC	.0214	.0214	.0214	.0214
* FEEDSTOCK				
DFC-GAS	-1	-1	-1	-1
* PRODUCT-YIELD(PERC)				
STEAM	1	1	1	1
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2	58	230	670	1000
NOX	500	500	500	500
+				

PRODUCER PLANT UNIT	UTILITIES FURNACES FURNACE-NG	UTILITIES FURNACES FURNACE-RG	UTILITIES FURNACES FURNACE-RO	UTILITIES FURNACES FURNACE-FL
*	FURNACE-NG.NT	FURNACE-RG.NT	FURNACE-RO.NT	FURNACE-FL.NT
* COSTDATA				
VAR-COSTS	.2	.2	.3	.2
ABATM-COST				
EFFICIENCY	.9	.9	.87	.9
UFAC	.0214	.0214	.0214	.0214
* FEEDSTOCK				
NATURALGAS	-1			
REF-GAS-U		-1		
REF-OIL-U			-1	
FLX-GAS				-1
* PRODUCT-YIELD(PERC)				
HEAT	1	1	1	1
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2		10	1463	50
NOX	85	115	192	80
+				

PRODUCER PLANT UNIT	UTILITIES COGENARATION COMB-CYCLE	UTILITIES COGENERATION COMB-CYCLE	UTILITIES COGENERATION GASTURBINE	UTILITIES COGENERATION GASTURBINE
*	COMB-CY-NG.NT	COMB-CY-RG.NT	GASTURB-NG.NT	GASTURB-RG.NT
* COSTDATA				
VAR-COSTS	.77	.77	.77	.77
ABATM-COST				
EFFICIENCY	.82	.82	.84	.84
UFAC	.0233	.0233	.0233	.0233
* FEEDSTOCK				
NATURALGAS	-1		-1	
REF-GAS-U		-1		-1
* PRODUCT-YIELD(PERC)				
STEAM	.55	.55	.60	.60
POWER	.45	.45	.40	.40
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2		10		10
NOX	135	149	135	149
+				

PRODUCER PLANT UNIT	UTILITIES COGENARATION BACKP-TURB	UTILITIES COGENERATION BACKP-TURB	UTILITIES COGENARATION BACKP-RO	UTILITIES COGENERATION BACKP-CO
*	BCKTURB-NG.NT	BCKTURB-RG.NT	BCKTURB-RO.NT	BCKTURB-CO.NT
* COSTDATA				
VAR-COSTS	.90	.90	1.08	2.00
ABATM-COST				
EFFICIENCY	.90	.90	.90	.85
UFAC	.022	.022	.022	.0233
* FEEDSTOCK				
NATURALGAS	-1			
REF-GAS-U		-1		
REF-OIL-U			-1	
COAL				-1
* PRODUCT-YIELD(PERC)				
STEAM	.80	.80	.80	.80
POWER	.20	.20	.20	.20
* ENVIRONMENTAL EFFECTS (T/PJ)				
SO2		10	1463	684
NOX	70	69	102	150
+				

PRODUCER PLANT UNIT	UTILITIES COGENARATION COND-TURB	UTILITIES COGENERATION COND-TURB	UTILITIES COGENERATION COND-TURB
*	CNDTURB-NG.NT	CNDTURB-RG.NT	CNDTURB-RO.NT
* COSTDATA			
VAR-COSTS	.9	.9	1.0
ABATM-COST			
EFFICIENCY	.33	.33	.33
UFAC	.022	.022	.022
* FEEDSTOCK			
NATURALGAS	-1		
REF-GAS-U		-1	
REF-OIL-U			-1
* PRODUCT-YIELD(PERC)			
POWER	1.0	1.0	1.0
* ENVIRONMENTAL EFFECTS (T/PJ)			
SO2		10	1463
NOX	70	69	102
+			

```
==================================================================
PRODUCER      UTILITIES
PLANT         DISTRIBUTE
UNIT          DISTRIBUTE
==================================================================

              DISTRIB-ST.NT
*             =============

*  COSTDATA
  VAR-COSTS
  ABATM-COST
  EFFICIENCY       1.0
  UFAC             1.0

*  FEEDSTOCK
  STEAM-P         -1

*  PRODUCT-YIELD(PERC)
  STEAM            1.0
```