*Institut für Wirtschaftspolitik
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SEMINARARBEIT

Conventional Energy Supply in INDONESIA

(WS 2000/01)

Specially: Power generation

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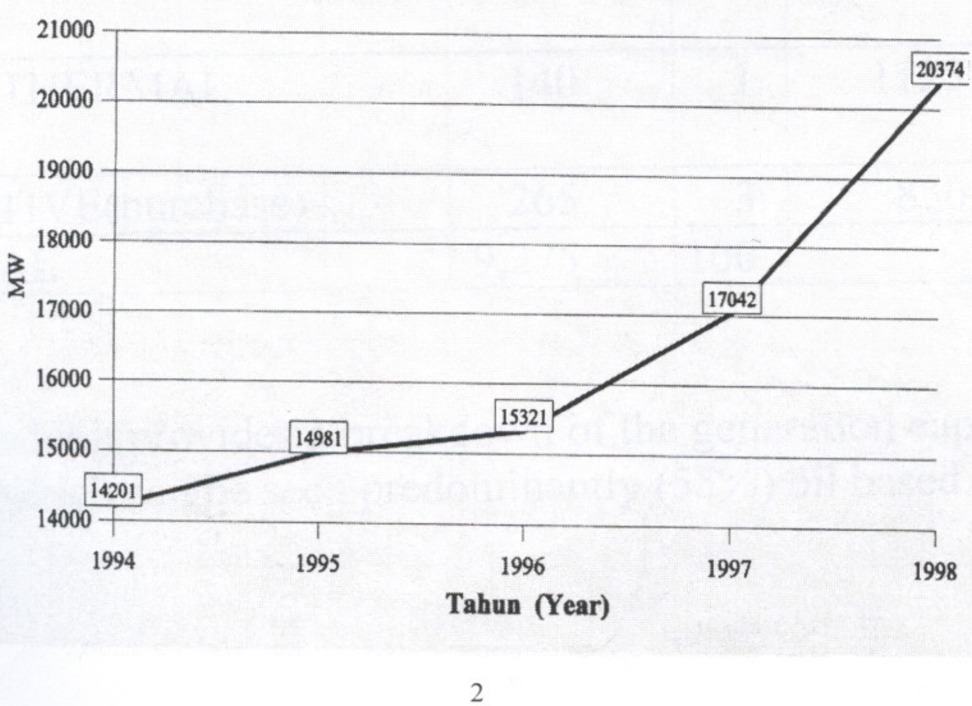
Chapter I: Background Information

1.1 PLN

The National Electricity Authority of Indonesia, ***PLN*** is responsible for generating, transmission and distribution o f electricity as well as the planning, construction and operation of facilities required to provide electricity .
PLN's national energy sales increased from 2,444GWh in 1974/75 to 27,741GWh in 1989/90, at an average annual growth rate of 16,3 percent. Over the same period, the number of customers showed annual growth rate of 16,2 percent. Comparable growth rates have been achieved in Java.
PLN's record in achieving a high connection rate for new customers is remarkable. Over the decade 1979/80 to 1989/90, PLN added over 8 million new customers, that mean's over 800.000 connections per year. In spite of this impressive record, the potential for electricity sales growth in the future remains high.
We should not forget that the electrification ratio is still below 28 percent even in Java, the most electricified island.

Gambar 1. **Total Kapasitas Terpasang**
Figure *Total of Power Plants Capacity*



1.2 Installed capacity andgeneration mix 1990

To better understand this point I prefer to represent the situation in 1990 as a table.
At the and of 1990 ***PLN*** had a total installed capacity of 9,275 MW.

PLN's capacity and generation mix in 1990					
Power Plants	Fuel	Installed capacity in MW	%	Energy Generation in GWh	%
STEAM	Oil	2,081	22	10,284	30
	Coal	1,730	18	10,910	31
GAS TURBINE	Gas	130	1	235	1
DIESEL	Oil	1,870	20	3608	10
HYDRO	-	2,095	22	5675	16
GEOTHERMAL	-	140	1	1125	3
CAPTIVE(purchase)	-	265	3	856	3
TOTAL		9,275	100		100

The exhibit provides a breakdown of the generation capacity mix, which can be seen predominantly (55%) oil based.

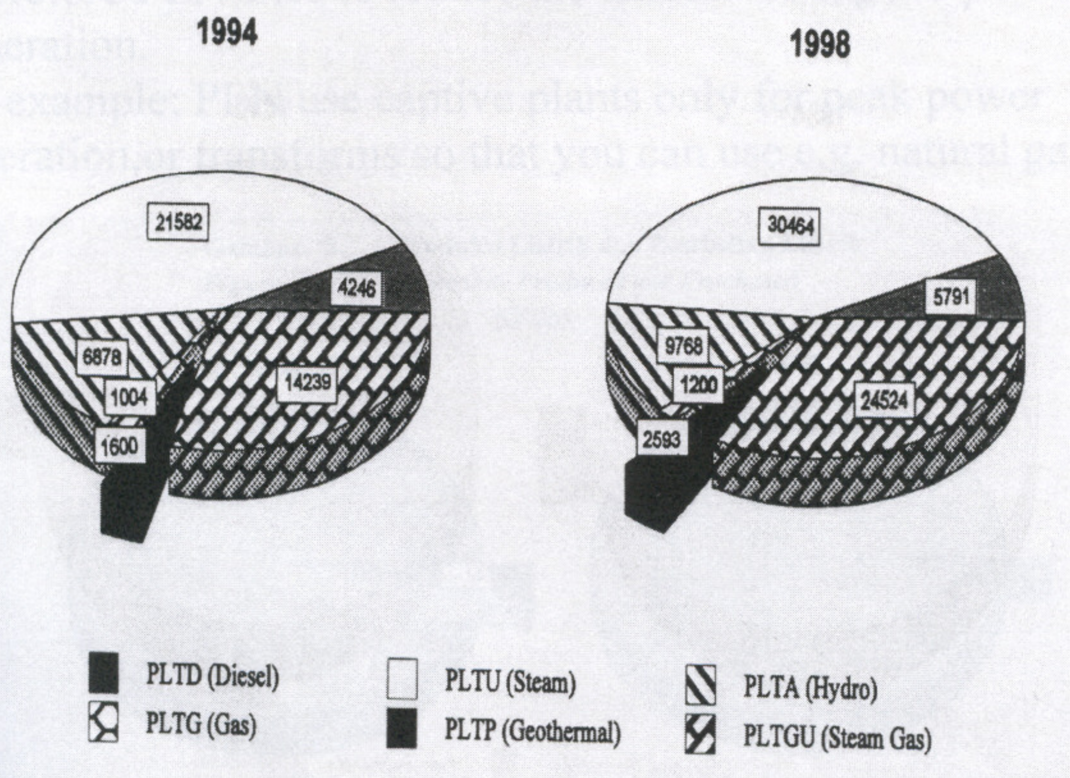
What about the following years?

One thing that we can do is to look at the development and compare it.
It seems that ***PLN***'s electricity supply increase extremely. In 1998 is more than double electricity supply as in 1994.

For example:

	1994	1998
Capacity in MW	14201	20374
Generation in GWh	50900	70900
Purchase captive Energy	1400	500

Gambar 4. Produksi Listrik Menurut Jenis Pembangkit
Figure Electricity Produced by Type of Power Plant
(GWh)



1.3 Captive Energy

In spite of the high growth rates, ***PLN*** has historically not bee able to supply all industrial demand.

Therefore the Ministry of Mining and Energy has given licenses to a few rural electric cooperatives to generate and distribute power in areas not connected to ***PLN***'s network.

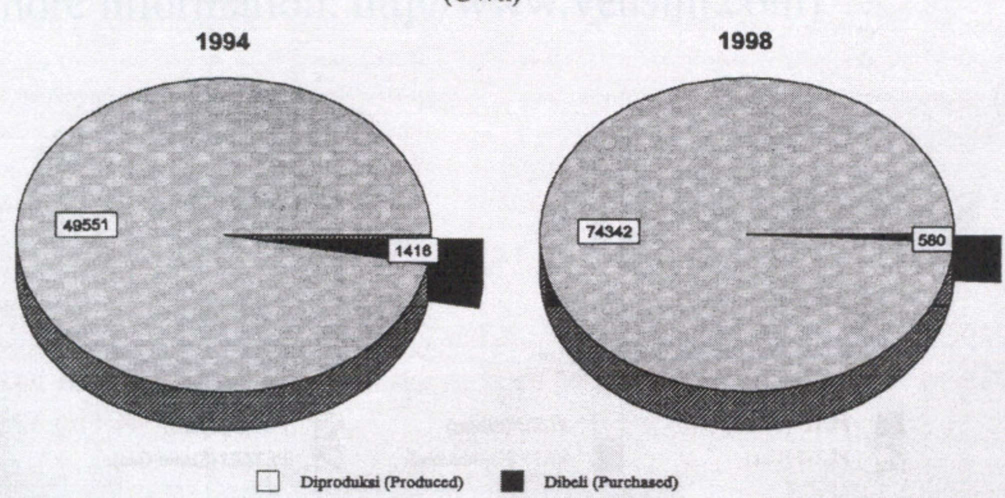
In addition many industrial enterprises got permits from Ministry of Mining and Energy and they installed captive generating plants to meet their electricity needs.

The amount of captive generating plants in industry is expected to grow, because it is cheaper for individual customers to self-generate than to buy by PLN.

But the most used fuel for captive generation is diesel. Therefore ***PLN*** tries to reduce the amount of captive power generation.

For example: PLN use captive plants only for peak power generation,or transforms so that you can use e.g. natural gas.

Gambar 3. Produksi Listrik dan Pembelian Listrik
Figure Electricity Produced and Pruchased
(GWh)



Chapter II: Vensim – Modeling - Data

2.1 Vensim

I built my model with *Vensim.*

Vensim is a visual modeling tool that allows you to conceptualize, document, simulate, analyze and optimize models of dynamic systems.

Vensim provides a simple and flexible way of building simulation models from causal loop or stock and flow diagrams.

By connecting word with arrows, relationships among systems variables are entered and recorded as causal connections. This information is used by the Equation Editor to help you form a complete simulation model
You can analyze your model throughout the building the variable and also at the loops involving the variable.

When you have built a model that can be simulated, *Vensim* allows you throughly explore the behavior of the model.

(For more information: http//www.vensim.com)

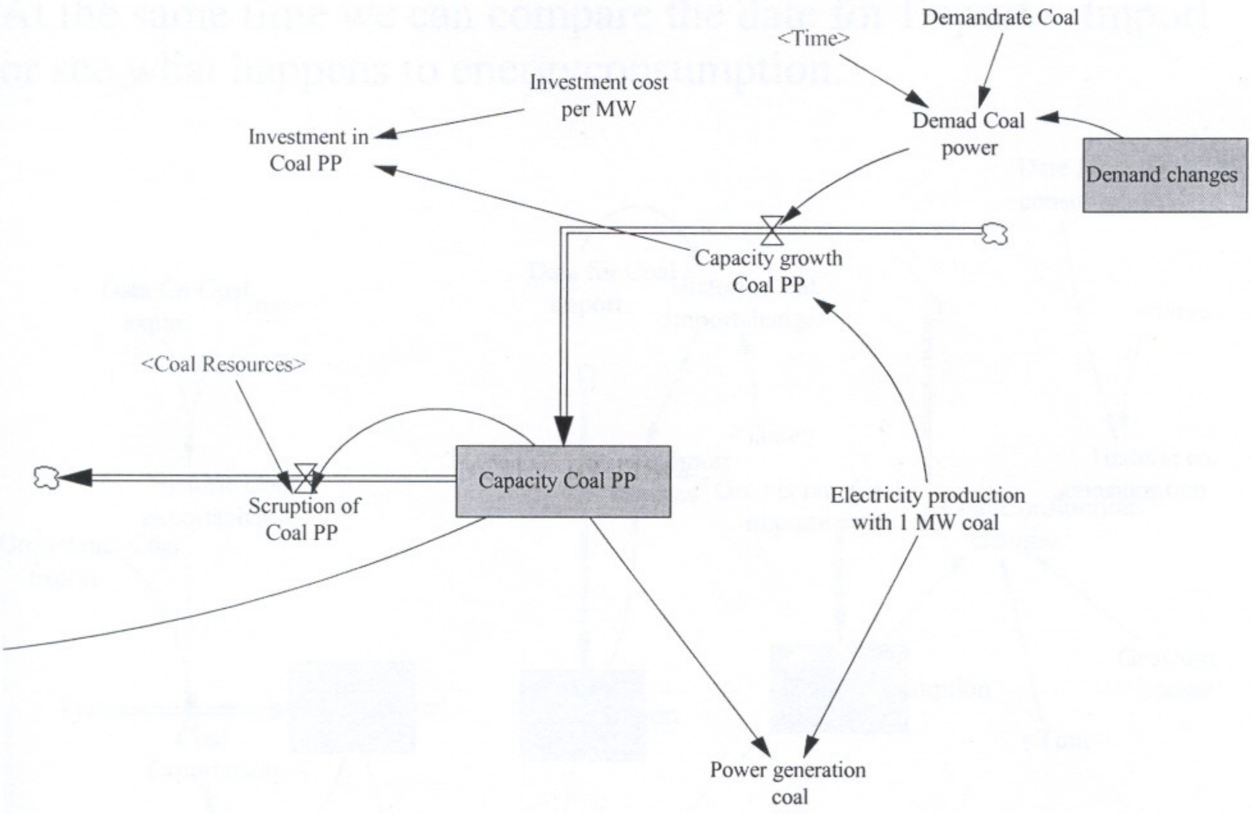
3.2 Summary about modelling

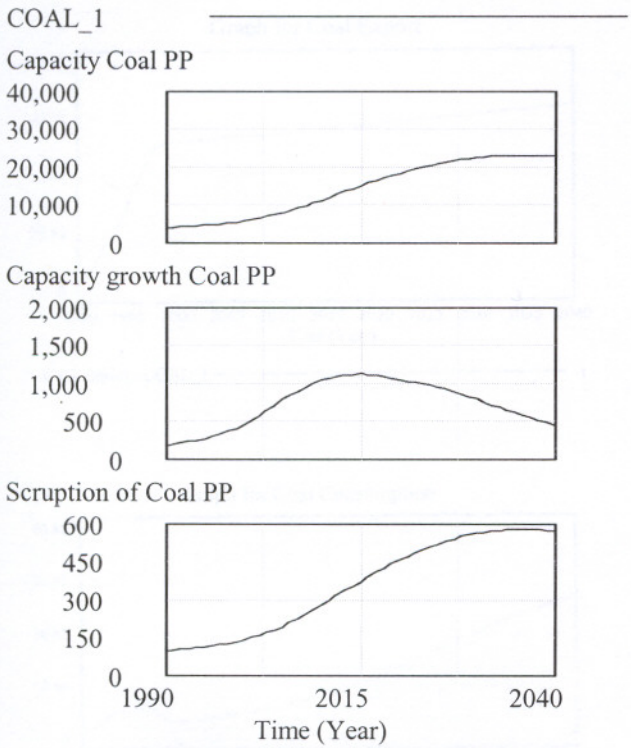
For my modelling I choosed the changes at the demand side.

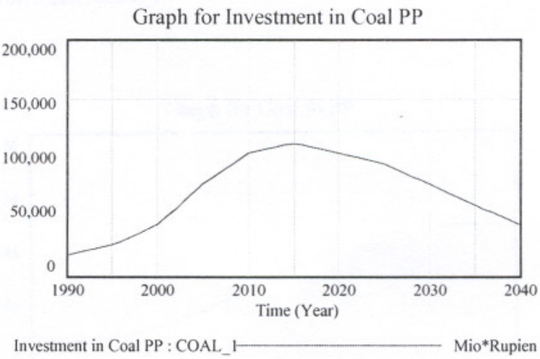
Suppose, for example, that we have ***x MW*** capacity and ***y MWh*** electricity demand in 1990.

Let us consider what happens to our capacity whwn the electricity demand grew to ***y +Δ MWh*** in 1991.

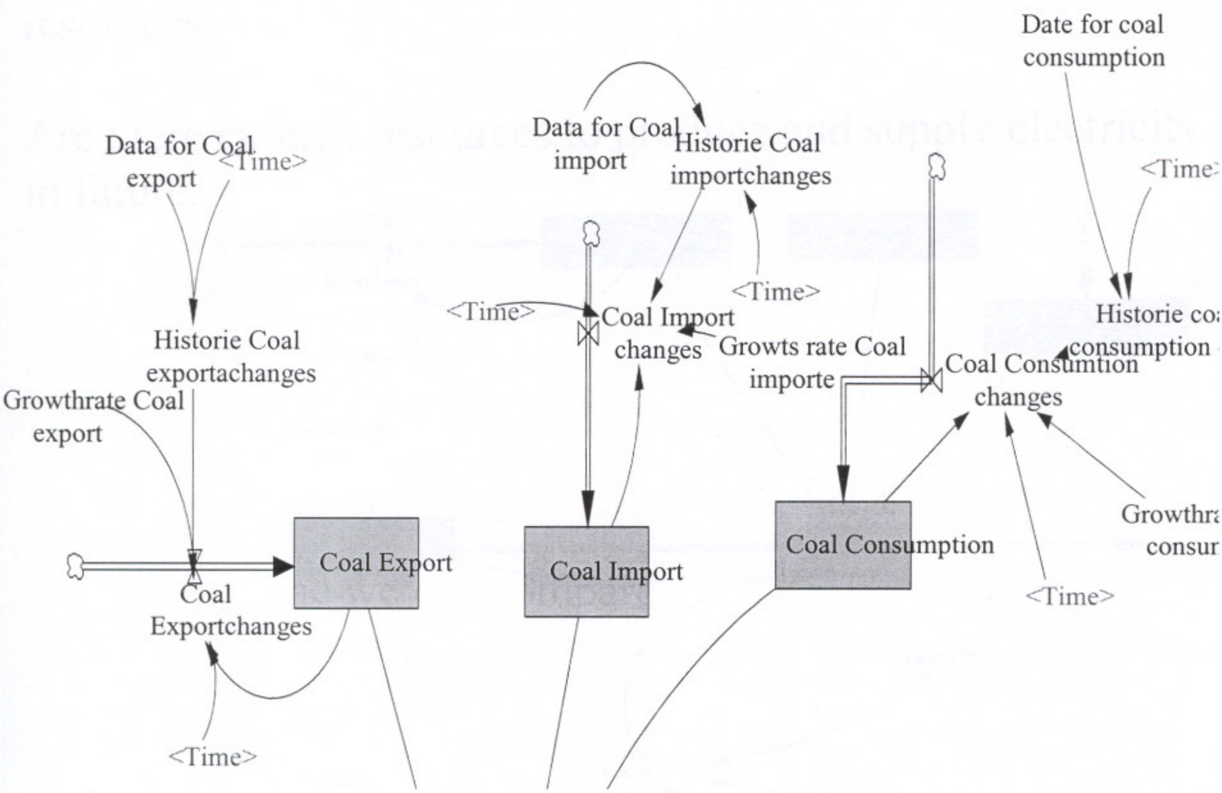
Now we need more capacity to rise our supply. That mean's an increase in our investments.

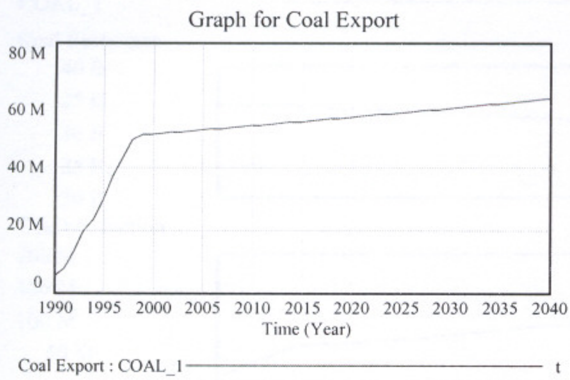


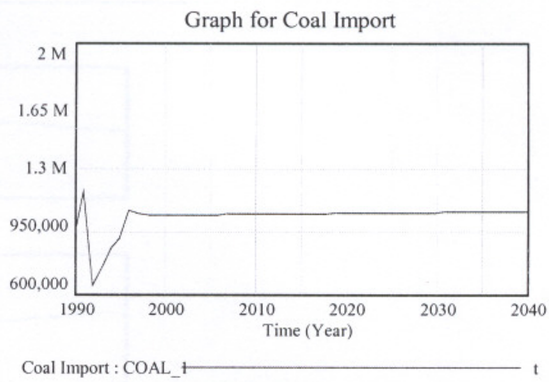


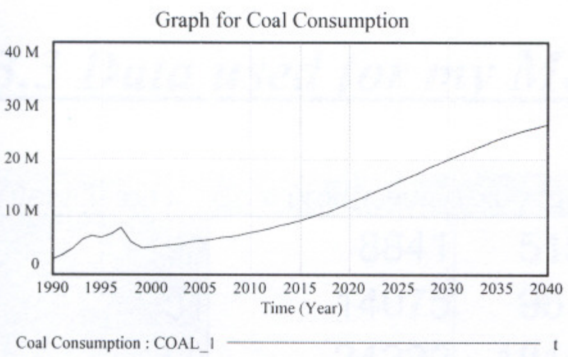


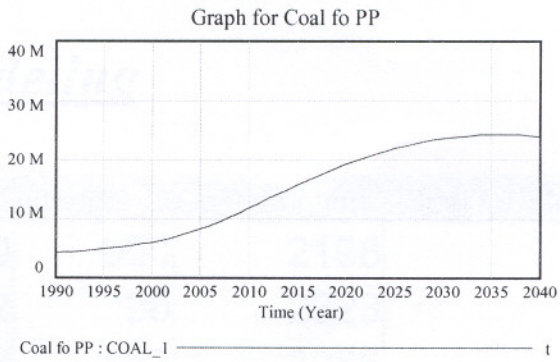
At the same time we can compare the date for Export – Import or see what happens to energyconsumption.





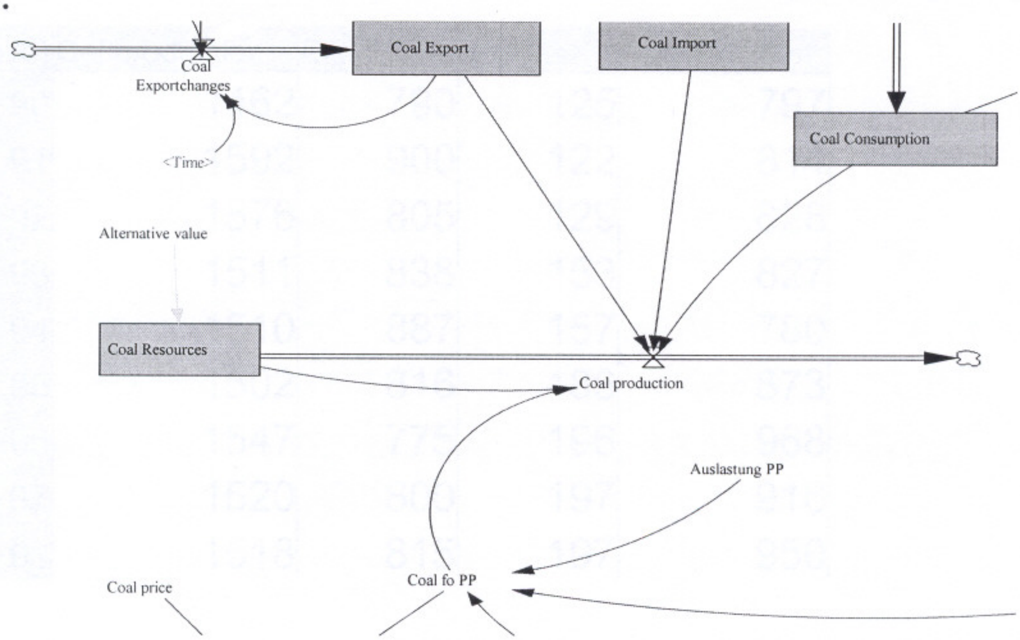


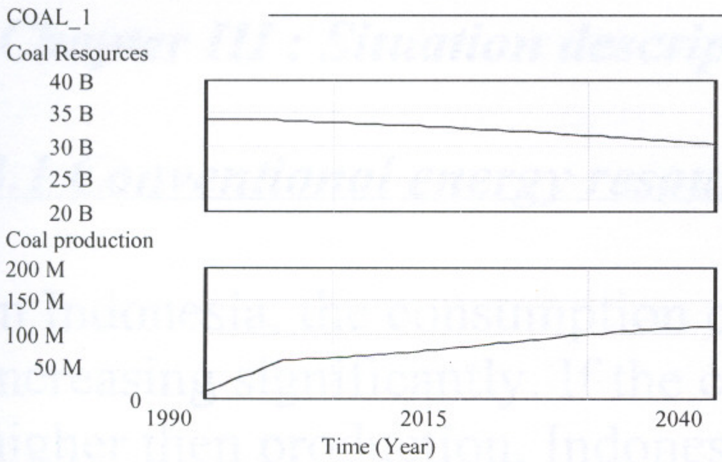




The most important point is, what happens to our conventional resources.

Are there enough resources to produce and supply electricity in future.





3.3 Data used for my Modeling

Year / T-tons	Coal production	Exports	Imports	Consumption	Coal for Electricity
90	8841	5159	950	2198	2214
91	14075	9612	90	2323	2341
92	24222	18148	122	3086	3110
93	30390	20928	338	4757	4557
94	34188	25109	273	6083	5474
95	45660	34523	528	5944	5721
96	55482	40172	509	5190	6436
97	60405	45997	496	8100	8466
98	66493	51577	495	6464	10608

Year / T-(bbl/d)	Oel production	Exports	Imports	Consumption
90	1462	790	125	797
91	1592	900	122	814
92	1576	805	129	828
93	1511	838	153	827
94	1510	887	157	780
95	1502	816	186	873
96	1547	775	196	968
97	1520	800	197	916
98	1518	815	197	950

Chapter III : Situation description – Proposal

3.1 Conventional energy resources

In Indonesia, the consumption of oil has been increasing significantly. If the consumption grows higher then production, Indonesia will soon become net oil importing country.
Therefore the use of diesel and other petroleum products for power generation should be limited in view of Indonesia's declining oil reserves.

Not surprisingly, PLN's plans do not forsee the construction of oil-fired steam power plants PLN rather intends to gradually retire the existing capacity.

A lot of the diesel based captive generation can be expected to be substituted by PLN's generation, once PLN's shortage of generation, transmission and distribution capacity ends.

The capacity decline in oil fired steam power plants is made possible by the additional installation of hydro or gas fired combined cycle power plants.

In order to reduce the dependency on oil and gas fuel, there is an alternative to maximize the utilization of coal which is abundant in Indonesia.

Indonesia’s coal is mostly lover quality. Nevertheless we can still use it as fuel material for electrical power plants or substitute for fossil fuel. Long term generation expansion planning with conventional resources should be based on coal.

The main reason behind this is that Indonesia has abundant coal reserves suitable for steam generation.
Reserves are estimated to exceed 32 billion tons, located primarily in Sumatra (23 billion tons) and in Kalimantan (9 billion tons).

In general Kalimantan coal is better quality than Sumatra coal.
The very low sulfur and ash content make Kalimantan coal particularly attractive for power generation as they comply with environmental regulations at low cost.

The major obstacle problem to coal use in Indonesia’s power plants will be the required transportation infrastructure.

Compared with 3.8 million tons in 1991, nearly 20 million tons of coal must be transported in year 2000 and 72 million tons in 2008.

There is not only coal reserves about that I want to give information.

Together with hydro power, natural gas the second most important energy resource for power generation.

On economic ground alone, gas seems to have a competitive edge over coal. But the need to exploit large gas reserves primarily for LNG exports and the higher economic value of gas in general industry use call for a prudent gas use strategy to power generation.

The use of marginal gas field's for power generation warrants assessing.
Regarding large scale power generation individual marginal gas field's will , in general, be too small to justify the installation of base or medium load power plants.

A cluster of marginal fields will be required to guarantee, that gas reserves will not be depleted before the and of the life time of large gas fueled power plants.

Individual marginal gas field’s may contain sufficient reserves for peak power plants.

3.2 For the future

PLN's expansion program in generating electricity depends on the demand scenario.

More emphasis should be given to cogeneration. The economically attractive potential is substantially higher
than the existing capacity.

Cogeneration systems have a total efficiency (electrical plus thermal) which is at least 20 % higher than the efficiency of systems producing electricity and thermal energy separately.

Thus, where there is a high demand for thermal energy – industrial zones are prime candidates – the possibility of installing combined heat and power plants should be thoroughly assessed.

High investment costs and increasing fuel prices make utilities and manufactures to increase the efficiency of power plants.

Regarding conventional thermal power plants, experts forecast that natural gas fired combined cycle plants could reach an efficiency of more than 60 % .

The efficiency of coal fired steam power plants whit desulphurization unit's forecast to approach 50 %.

Regarding novel technologies, coal fired generating technologies will be in the center of interest given that coal is extremely likely to become Indonesia's dominant energy resource for power generation.

While coal is so interesting here are some more details.

Three coal using technologies, of which pilot plants already exists or are under construction, could be particular intersting for Indonesia.

1.) Gas / Coal combustion(G/CC)
2.) Fluidized bed combustion(FBC)
3.) Integrated coal and gasification combined cycle (IGCC)

These plants have already reached commercial maturity and could be attractive for Indonesia in the near future.

Compared to conventional coal fired power plant, the plants have a higher efficiency and lower emmision.

Though cost estimates of FBC and IGCC plants must be interpreted cautiously as long as only pilot plants exist, many experts belive that the specific investment cost will be in order of conventional plants with desulphization unit.

This also applies to G/CC plants, where cost estimates are more reliable, because several large plants already exist.

3.3 Alternative power generation

Here we have tree several possibilities to generate electricity.

1.) Hydro power:

Sumatra, Kalimantan, Sulawesi and Irian Java offer an attractive potential for developing large hydro power plants, but the relatively low demand in these regions and often long distance to the customers limits the potential which is economically exploitable.

On Java, for example, development will focus on pumped storage plants to be used for peak power generation.

Micro hydro plants are likely to an attractive option for rural electrification.

2.Geothermal:

Geothermal is likely to become more increasingly attractive in future, but its limited potential will prevent that it ever becomes a major energy resource.

There is no needs to subsidize the power production from geothermal energy. Pilot projects already exists in Indonesia.

An cost estimate indicate that geothermal steam based power generation can be expected to become increasingly competitive whit other sources if the sites are not too far away from the consumer center

3.)Solar Energy

Among other energy resources, solar energy converted in photovoltaic systems in to electricall energy could become an important source for electricity generation in the very long term.

At present, small systems have generating costs of US $ 1,50 per kWh. Despite the relatively high costs, calculations shows that small PV systems may already be the least cost power supply option for rural areas.

As generating costs likely to further decline, small PV modules could make significant contribution to rural electrification.

That mean's PV systems should be supported or subsidized.

Further, empirical evidence shows that novel technologies face other barriers than costs.

Regarding PV systems, it is, for example, often believed, that there will be no electricity during the nighttime or PV cells break easily.
Information campaigns will be a pre-requisite before installing PV systems.

3.4 A close look coal and CO_2 emmision

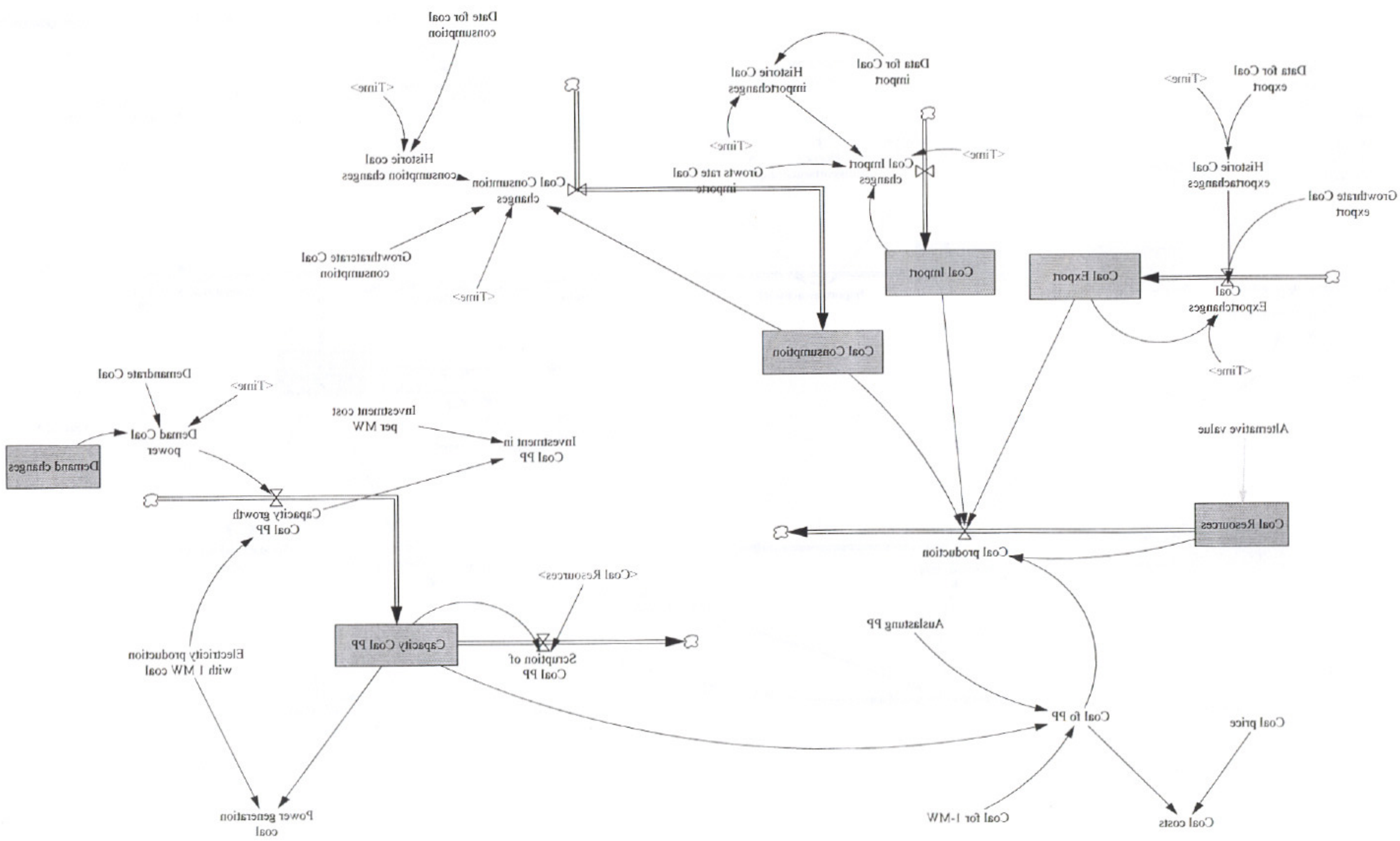
Until today, the general public, I believe, harbours the view that Coal is black and dirty causing a lot of emission gases and polluting the air in Indonesia severely.

With regard to the amount of emissions produced by hydro-carbon fuel in Indonesia a recent study by Manfred Kleeman in 1994 gave the following Table.

Polluting Emission from the use of Energy (1993)(T)

Type of Energy	Consumption	Emission	Emission	Emission	Emission	Emission
	1000T	CO_2	SO_2	NOx	SPM	VHC
Coal	8410	17490	54,39	49,44	7,93	0,39
Oil	37808	118720	300,94	155,69	9,94	206
Natural Gas	9998	26200	0,01	10,38	0	1
Hydro		0	0	0	0	0
Geothermal		0	0	0	0	0
Biomass	171428	217716,1	25,1	125,48	1505,76	250,96
Total		380126,1	377,44	340,99	1523,63	458,35

The table indicates that above view is not quite correct. The real "Culprits" who are polluting the Indonesian air in large amounts are in fact Oil and Biomass.



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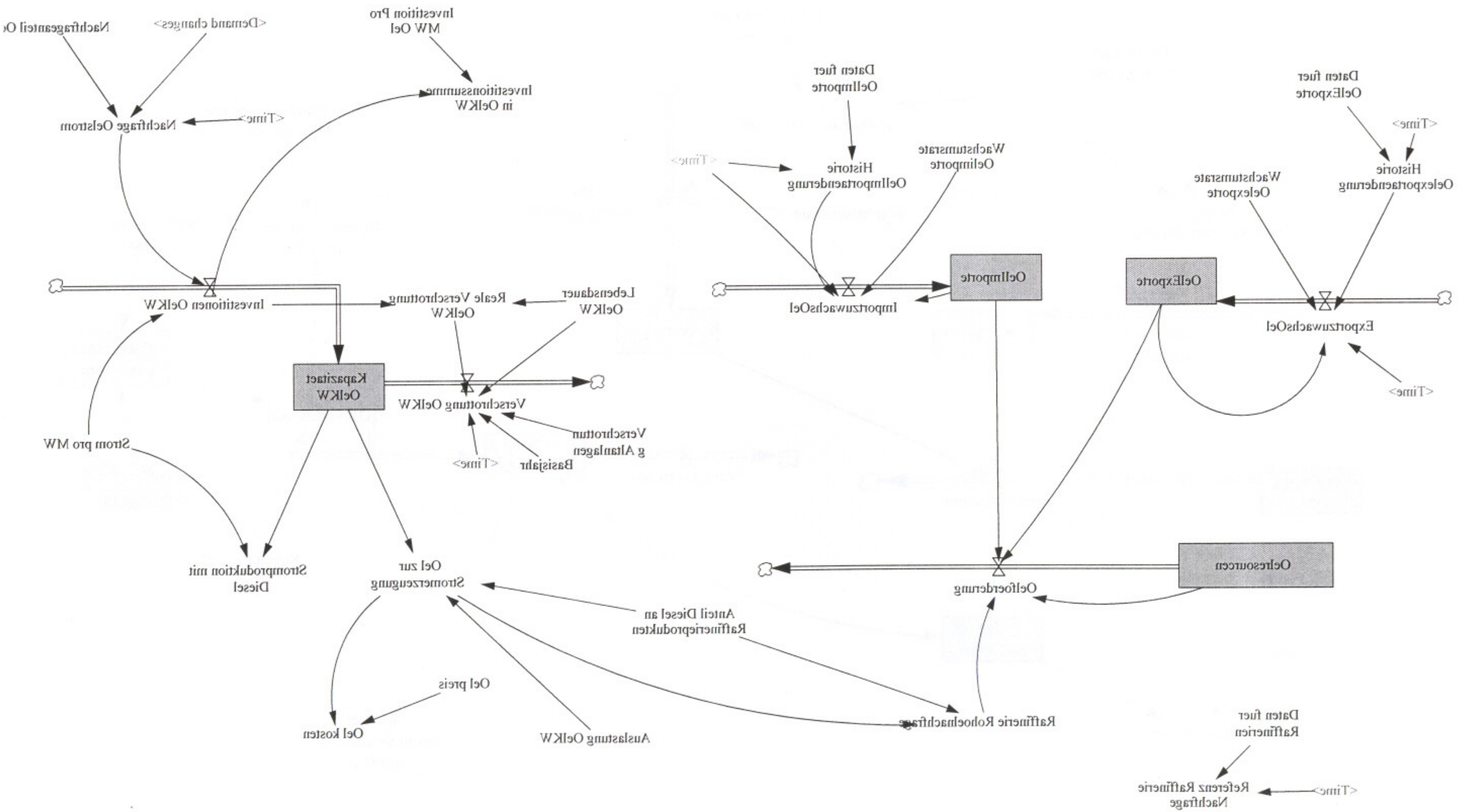

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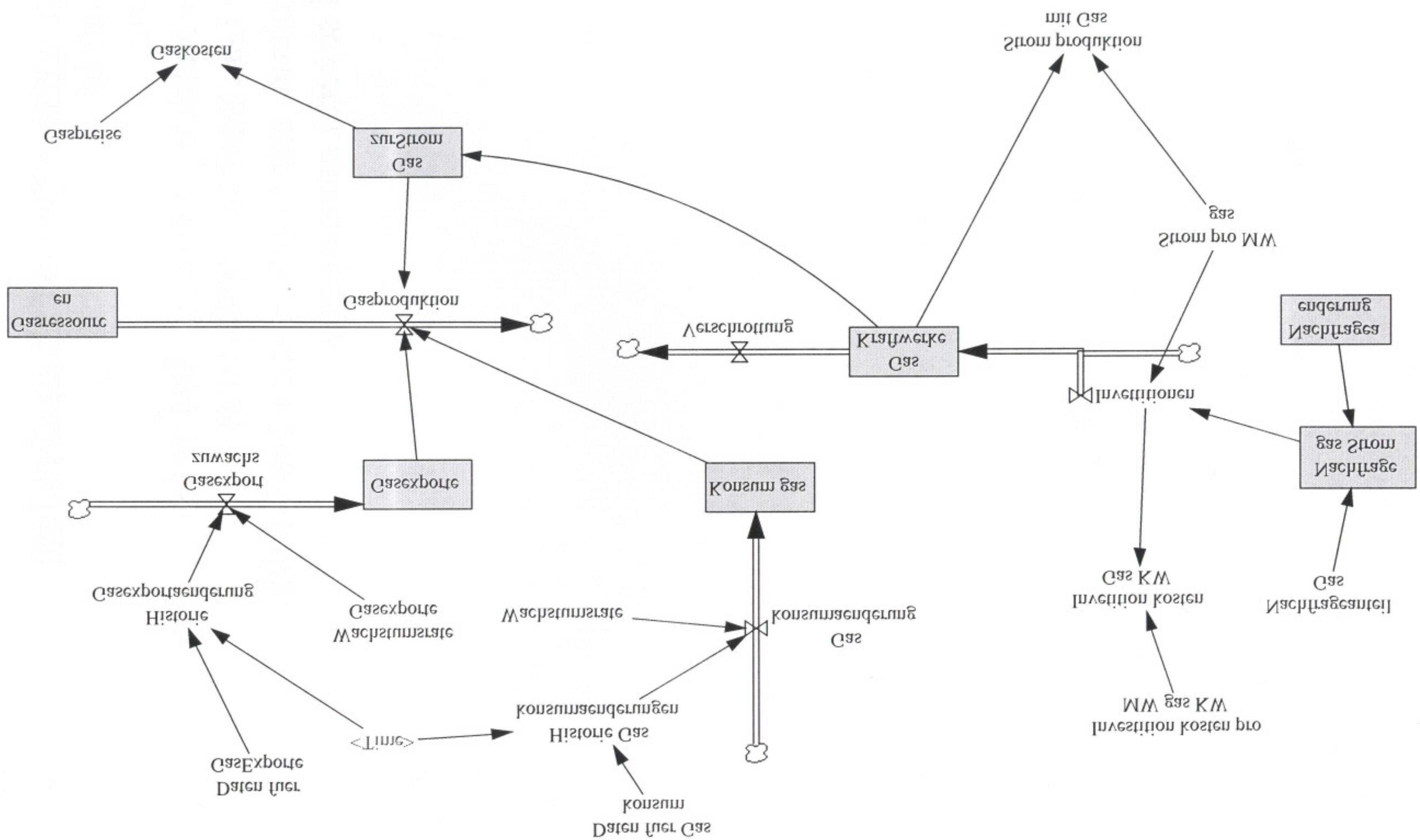

Gaskosten
Gaspreise
Gas zurStrom
Strom produktion mit Gas
Strom pro MW gas
Gasressourcen
Gasproduktion
Verschrottung
Kraftwerke Gas
Nachfrageaendering
Invetitionen
Nachfrage gas Strom
Gasexport zuwachs
Gasexporte
Konsum gas
Historie Gasexportaenderung
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Nachfrageanteil Gas
Historie Gas konsumaenderungen
<Time>
Daten fuer GasExporte
Daten fuer Gas Konsum
Invetition Kosten pro MW gas KW

LITERATURE

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